REPORTER'S TRANSCRIPT OF SIXTH DOSE ASSESSMENT ADVISORY GROUP MEETING

JANUARY 7, 1983

VOLUME II

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE

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Nevada Operations Office

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REPORTERS' TRANSCRIPT

OF

SIXTH DOSE ASSESSMENT ADVISORY GROUP MEETING

Auditorium
2753 South Highland Drive
Las Vegas, Nevada
January 7, 1983

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DOSE ASSESSMENT ADVISORY GROUP

Members Present:

Dr. Robert D. Moseley, Chairman
Professor
Department of Radiology
School of Medicine
University of New Mexico

Dr. John A. Auxier
Director
Industrial Safety & Applied Health Physics
Oak Ridge National Laboratory
P.O. Box "X"
Oak Ridge, Tennessee 37830

Dr. Glyn C. Caldwell
Chief
Cancer Branch Center for Disease Control
1600 Clifton Road, NW
Atlanta, GA 30333

Dr. James E. Carothers
Physicist
Member of Director's Technical Staff
Lawrence Livermore National Laboratory
University of California

Dr. George W. Casarett
Department of Radiobiology and Biophysics
School of Medicine
University of Rochester
601 Elmwood Avenue
Rochester, NY 14642

Dr. John S. Malik
Physicist
Staff Member National Security Program
Los Alamos National Scientific Laboratory
University of California
P.O. Box 1663
Los Alamos, NM 87545

Dr. Roger O. McClellan
Director
Inhalation Toxicology Research Institute
Lovelace Foundation
P.O. Box 5890
Albuquerque, NM 87115

Dr. James E. Sarn
Assistant Director
Division of Disease Control Services
411 North 24th Street
Phoenix, AZ 85008

Mr. Joseph O. Ward
Chief
Radiologic Health Section
California Department of Health Sciences
714 "P" Street
Sacramento, CA 95814

Dr. McDonald E. Wrenn
Department of Pharmacology
Radiobiology Division
University of Utah, Building 522
Salt Lake City, UT 84112

Mr. Michael D. Zimmerman
Attorneys at Law
WATKISS AND CAMPBELL
310 S. Main Street, Suite 1200
Salt Lake City, UT 84101

Members Absent:

Dr. Edward L. Alpen
Director
Donner Laboratory
University of California

Mr. William J. Breed
Anthropologist
Museum of Northern Arizona
Route 4, Box 720
Flagstaff, AZ 86001

Mr. Seymour Jablon
Director
Medical Follow-Up Agency
National Academy of Sciences
2101 Constitution Avenue
Washington, DC 20418

Dr. Ernest L. Mazzaferri
Acting Dean
University of Nevada
School of Medical Sciences
Reno, NV 89557

Dr. Roger D. Miercort
Chief
Department of Radiology
Washoe Medical Center
77 Pringle Way
Reno, NV 89502

Others Present:

TASK GROUP PERSONNEL

Dr. Lynn R. Anspaugh
Lawrence Livermore National Laboratory
University of California
Post Office Box 808
Livermore, CA 94550

Dr. Gilbert D. Potter
Environmental Monitoring and
Support Laboratory--Las Vegas

Mr. Thomas C. Mehas
Fallout Records Centralization
Project (FRCP)
Reynolds Electrical & Engineering
Co., Inc.
Post Office Box 14400
Las Vegas, NV 89114

Dr. Forest L. Miller
Desert Research Institute
4582 South Maryland Parkway
Las Vegas, NV 89109

Mr. Harold F. Mueller
U.S. Department of Commerce
Weather Service Nuclear Support Office
Post Office Box 14100
Las Vegas, NV 89114

Dr. Jerry Dummer
Los Alamos National Laboratory
University of California
Post Office Box 1663
Los Alamos, NM 87545

Dr. F. Ward Whicker
Radiology Laboratory
Colorado State University
Ft. Collins, CO 80521

UNITED STATES DEPARTMENT OF ENERGY

Nevada Operations Office

OFF-SITE RADIATION EXPOSURE REVIEW PROJECT

Staff Present:

JOHN R. GILPIN, ASSISTANT MANAGER FOR ADMINISTRATION, NV

ROBERT W. NEWMAN, ASSISTANT TO THE MANAGER FOR SCIENCE & TECHNOLOGY, NV

BRUCE W. CHURCH, DIRECTOR, HEALTH PHYSICS DIVISION, NV

MARSHALL PAGE, JR., DEPUTY PROJECT MANAGER

RICHARD V. NUTLEY

DAVID L. WHEELER

Others Present:

BATTELLE PACIFIC NORTHWEST LABORATORY

Ken Kosauke
Mark Rangel
Everett Wingo

COLORADO STATE UNIVERSITY

Thomas B. Kirchner
Mark Otis

DRI

Stanley W. Hutchinson
Carol B. Thompson

HOLMES & NARVER

Herbert Friesen

LAWRENCE LIVERMORE NATIONAL LABORATORY

Richard Corallo
John J. Koranda
Yook C. Ng

LOS ALAMOS NATIONAL LABORATORY

Richard Smale
Richard Henderson

Reynolds Electrical & Engineering, Co.

Ed Eubanks
Kim D. Lee
R. Grisham
Bernardo Maza
Nancy Rothermich
Stephen Rohrer
Roger C. Thompson

U.S. JOD

Ralph Johnson

WEATHER SERVICE NUCLEAR SUPPORT OFFICE

Charles Steadman

OTHER DOE IN ATTENDANCE

Buford Allen
Rick Betteridge
JoAnne Burrows
Paul B. Dunaway
Roy Maxwell
Chris West

OTHER PUBLIC IN ATTENDANCE

Paul Dawkins
Mary Manning
Darrel W. McIndoe, M.D.
James Murray
Richard Pratt

LAS VEGAS, NEVADA, JANUARY 7, 1983, FRIDAY, 8:30 A.M.

CHAIRMAN MOSELEY: It's 30 minutes after the hour Coordinated Universal Time, and we will begin with a presentation by Dr. Ng on the Progress on Internal Dose Assessment Models, and he will be followed by Dr. Anspaugh on another aspect of this subject.

Dr. Ng.

(Exhibit LRA-1)

DR. NG: May I have the second viewgraph now, please?

Now, this viewgraph (LRA-2) simply emphasizes that the documents by Hicks listed below have been published.

Next viewgraph (LRA-3) please. This viewgraph shows how the dose calculations are carried out, and it summarizes the basic calculations for the dose in somewhat different form than I've previously shown, but it is essentially unchanged. The DOS is the product of four terms. ER is the exposure rate 12 hours postdetonation. It varies with the shot and location. DEPNO is the deposition normalized to an exposure rate of 1 mR/hr at H+12. It varies with nuclide, event and time of arrival. INDEP is the integrated intake per unit deposition. It's specific for the individual and varies with the nuclide and event. DF is the dose factor which varies with the age group, nuclide and organ. The dose, therefore, is specific for the individual, event, radionuclide, and organ.

The calculations are carried out as shown on the next viewgraph (LRA-4). The INPUT data consists of the birthdates of the litigants; the dates of the various test events; the intakes per unit deposition for the individuals, nuclides, and events from Colorado State University; the residence locations and dates of residence at these locations, and the exposure rates and times of arrival for the events and locations.

The calculations for each litigant are made by selecting the normalized depositions and dose factors appropriate for the event, computing the doses, and then summing over the nuclides and events.

Our next viewgraph, please (LRA-5). As an example, this viewgraph summarizes the dose estimates for .. We list the organ doses for each of the 31 shots and the total dose. For the diagnosis is thyroid cancer, so that the organ of reference is the thyroid. Her residence was St. George, and six of the 31 events transported fallout to St. George: ANNIE, SIMON, HARRY, TESLA, ZUCCHINI, and SMOKY. The total thyroid dose is 40 rads, mostly from event HARRY, 36 rads.

Our next viewgraph, please (LRA-6). It is useful to know how the individual radionuclides contributed to the dose. We, therefore, calculated the individual contributions of the radionuclides to the dose and the fractional contributions to the total. We made calculations for each litigant and event that contributed to the dose, and for each litigant, and the total dose from all events. As an example, this viewgraph shows the results for from event HARRY. Thirteen organs are listed across the top; 20 nuclides are listed along the margin. The most important radionuclides and their contributions to the thyroid dose are highlighted. The nuclides that contribute one percent or more of the total thyroid dose are iodine-131, tellurium-132, and iodine-133. Now, the actual contributions are summarized in the next viewgraph.

This viewgraph (LRA-7) shows the most important contributions to the thyroid dose to from HARRY. Again, her residence is St. George; her age group is child; diagnosis, thyroid dose from HARRY, 36 rads. Now, iodine-131 contributes some 88 percent of the dose; Tellurium-132, two percent; and iodine-133 essentially the remainder of 10

percent. We also note the most important contributions to the lower large intestine, which is of interest because it's the organ that receives the second highest internal doses by ingestion, and the bone marrow dose, which is of interest because of the abundance of leukemia diagnoses. Thus, among the radionuclides that contribute five percent or more of the dose to the lower large intestine, are neptunium-239, strontium-89, yttrium-93, zirconium-97, barium-140, and neodymium-147. We recently added yttrium-93 to the list of nuclides because in reexamining our screening calculations we noted that Y-93 did, indeed, contribute some two percent or more of the total lower large intestine dose. For the bone marrow, among the nuclides that contributed the most are strontium-89, strontium-90, collectively contributing over 60 percent to the total dose. Iodine-131, tellurium-132, cesium-137, barium-140 contribute some five percent or more.

The next viewgraph (LRA-8) shows a similar distribution. Well, it shows the most important contributors to the thyroid dose to . from all events. Six of the 31 events contributed doses by virtue of distributing radioactivity over St. George. Fractional contributions are quite similar, as shown on the previous viewgraph (LRA-7), and this is not surprising since HARRY was the major contributor to the total dose from all events.

Again, I will go through this quickly, the most important contributions to the thyroid dose are from iodine-131, tellurium-132, and iodine-133; and, serially, the most important contributors to the dose to the lower large intestine are neptunium-239, strontium-89, yttrium-93, zirconium-97, barium-140, and neodymium-147. The most important contributors again to the bone marrow dose are strontium-89, strontium-90, iodine-131, tellurium-132, cesium-137, barium-140.

As another example, the next viewgraph (LRA-9) summarizes the dose

estimates for from all events and from the individual events. Residence for was Washington, Utah. His diagnosis was leukemia, and, therefore, the organ of reference is the bone marrow. We, therefore, highlight the bone marrow and the major contributors to the bone marrow dose, which totals 120 millirads. The events that contributed to this total dosage are again ANNIE, SIMON, HARRY, TESLA, ZUCCHINI, and SMOKY. The major contributor was HARRY, which contributed some 100 millirads to the bone marrow dose.

The next viewgraph (LRA-10) shows the contributions of the individual nuclides to the doses for . This is from all events. The most important contributors to the bone marrow dose are highlighted and examined in the next viewgraph.

(LRA-11) The major contributors to the bone marrow dose are strontium-89, strontium-90, in this case collectively contributing about two-thirds of the total dose, molybdenum-99, iodine-131, tellurium-132, iodine-133, cesium-137, and barium-140. Each contributed at least two percent. Major contributors to the lower large intestine are the same as fo and are quite typical. Let me just point out that it is interesting to note that the dose estimate for the thyroid of is 55 rad, which actually exceeds that for ; however, his diagnosis was not thyroid cancer but leukemia.

Next viewgraph, please (LRA-12). Three of the litigants who experienced in utero exposures are as summarized in this viewgraph. Here we list the litigants, the birthdates of the litigants, their residences, the events to which they were exposed while in utero, and the dates of the events. was exposed near the end of the first trimester, and and were exposed near the beginning of the second trimester. Now, we selected as the surrogate for

estimating maternal doses for , and . Her thyroid dose estimates are the highest among those for adult women who were exposed to fallout from FOX and HARRY at Cedar City, and the second highest among all adults for that matter who were exposed to fallout from these events at Cedar City. , was selected as the surrogate mother for estimating maternal doses for . Her thyroid dose estimate is the highest among the adults who were exposed to fallout from ZUCCHINI at St. George.

Since the dose from radioiodines to the fetal thyroid at the beginning of the second trimester is still less than that to the maternal thyroid, the limiting dose to the fetal thyroid is assumed to be the dose estimate for the maternal thyroid. Now, the dose to the fetal total body and other fetal organs is assumed to be that to the maternal total body or uterus. Rapid bone development and accumulation of calcium and strontium do not yet occur at the beginning of the second trimester; so the dose estimates for the in utero exposures are summarized in the next viewgraph.

(LRA-13). Now these turn out to be less than one millirad for "Total Body (and other organs)" or one millirad in the case of ; and less than 0.06 of a rad for , less than 0.5 of a rad for ., and less than 0.2 of a rad for . These fetal dose estimates then may be added to the previously calculated totals.

Let me simply mention that in the handouts which contain the summaries of the individual dose estimates, we also list two separate sheets for and . had a diagnosis of cancer to the pancreas, and we, therefore, included pancreas as a reference organ and calculated doses to the pancreas. In calculating doses to the brain, which is the organ of reference for , we used pancreas as a reference organ, and making note that the dose to the brain is approximately equal to the

dose to the pancreas and certainly less than two times the dose to the pancreas.

Now we previously stated that we would evaluate the dose to the salivary glands and the lactating breast from the ingestion of Iodine-131. Both of these tissues can concentrate iodine. Serous salivary glands, stomach, lactating breast, and certain other tissues possess iodine concentrating mechanisms, or an iodine concentrating mechanism that is comparable to that of the thyroid.

Next viewgraph, please (LRA-14). We can summarize the readily available data by examining the fluid-to-plasma ratio. We list the average fluid-to-plasma ratio and the range of values for saliva, for gastric juice, and milk; and these are the references from which the data were derived. In the case of the salivary glands, the fluid-to-plasma ratio are to a large extent independent of the plasma concentration and secretion rate. In the case of gastric juice, the fluid-to-plasma ratio varies inversely with the collection rate.

May I have the next viewgraph, please (LRA-15). So we made attempts to estimate dose factors to extrathyroidal iodide concentrating tissues for iodine-131 as follows: The half-life of iodine in extracellular fluid is assumed to be the rapidly turning-over component of the iodine retention function with a half-life of 0.35 days; and this is equivalent to an effective turnover rate of about two per day. Now the time integral of the concentration in extracellular fluid is then 0.7, assuming that 0.7 of the ingested iodine goes to the extracellular fluid, and the 2.7×10^4 ml corresponds to the iodide space, and the two per day is the turnover rate that we just examined above.

This leads to a time integral then of the concentration in extracellular fluid of 1.3×10^{-5} d/l. Now we assume that the equivalence of

the time integrals in fluids concentrated from extracellular fluid, and in the tissues from which these fluids are derived, so we have then for the time integral of the concentrations in the concentrated fluids, 1.25 x 10^{-5} x R, where R is the fluid-to-plasma ratio. Now R is a poor choice inasmuch as it also represents Roentgens, but, nonetheless, R is meant to be the fluid-to-plasma ratio.

The dose factor then for extrathyroidal iodide concentrating tissues, is this 1.25 x 10^{-5} R d/g x 0.2 MeV, corresponding to the energy from the disintegration of iodine-131 times the conversion factor of 51.2 rad per (μCi-d/g)-MeV, and this is then the resulting expression for the dose factor for extrathyroidal iodide concentrating tissues.

Next viewgraph, please (LRA-16). We also made an attempt to estimate a dose factor for iodine-131 to the lactating breast by making note of the recoveries of, well, iodine-131, or of the dietary iodide in milk. Now 0.03 - 26.8% of I-131 administered to women at the conclusion of the last breast feeding, resulted in the recovery of this range of values of the isotope in milk. In the case of dietary stable iodide, ten percent or less of the daily ingested iodide is secreted in milk. And this varies inversely with the dietary intake of iodine. So the transfer coefficient and time integral then of the concentration in milk following a single intake of iodide, assuming a milk secretion rate of one liter per day, and this seems to be a reasonable value for nursing mothers, leads to, well, a transfer coefficient, or time integral of 0.1 of a day per liter, and this is equivalent to 10^{-4} d/ml. Now again we assume the equivalence of the time integrals in milk and lactating breast, so we have 10^{-4} d/g for the time integral in the lactating breast. Dose factor then is this number times the 0.2 MeV times the conversion factor, and we get about 1.0 x 10^{-3} rad/μCi.

Next viewgraph, please (LRA-17). This is simply a comparison of those factors for iodine-131 then. This is what is in use, or what we estimate, for the dose factor for iodine-131 and extrathyroidal iodide concentrating tissues. For thyroid, we use a dose factor of 1.9 rad/μCi. For the lactating breast our estimate is -- excuse me. The dose factor for the breast is 4.5×10^{-4} rad/μCi. For the lactating breast we have two values, depending on our approach. 1×10^{-3} or 3×10^{-3}. For salivary glands, 7×10^{-3}. For stomach, and this is -- I don't want to emphasize stomach here -- assuming the stomach as an extrathyroidal iodide concentrating organ, total body, approximately 1×10^{-3}. These are the dose factors from MIRD. This is found in the Journal of Nuclear Medicine, 1975, and from ICRP-30.

Now the next slide (LRA-18) summarizes some hypothetical dose estimates -- well, this is actually patterned after one of our litigants, and the assumption is that she is a nursing mother. These are the calculated values in our printouts, assuming the adult female. Breast, 0.024. Now if we made a calculation for the dose from iodine-131 to the lactating breast, we would have -- from iodine-131 alone we would have an additional of approximately 50 percent to be added to this calculated value. And in the case of the salivary glands, we estimate, oh, 29 millirads which approximates the dose from all radionuclides to the total body.

Now in summary then, the dose to extrathyroidal iodide concentrating organs from iodine-131 is very low relative to that to the thyroid. Lynn now will follow with various other items.

CHAIRMAN MOSELEY: Are there questions for Dr. Ng at this point. Thank you very much.

INDIVIDUAL DOSE ASSESSMENT MODELS AND DOSE TO LITIGANTS

Presentation to
THE DOSE ASSESSMENT ADVISORY GROUP
Las Vegas, NV; January 6 and 7, 1983

Lynn R. Anspaugh and Yook C. Ng
Lawrence Livermore National Laboratory

LRA-1

THE SOURCE-TERM DATA HAVE BEEN PUBLISHED

H.G. Hicks, Results of Calculations of External Gamma Radiation Exposure Rates from Fallout and the Related Radionuclide Compositions, Lawrence Livermore National Laboratory, UCRL-53152, Parts 1 through 8 (1981).

H.G. Hicks, Calculated Concentrations of any Radionuclide Deposited on the Ground by Release from Underground Nuclear Detonations, Tests of Nuclear Rockets, and Tests of Nuclear Ramjet Engines, Lawrence Livermore National Laboratory, UCRL-53228 (1981).

H.G. Hicks, "Calculation of the Concentration of any Radionuclide Deposited on the Ground by Offsite Fallout from a Nuclear Detonation," Health Phys. 42, 585 (1982).

DOSE ESTIMATES FOR LITIGANTS VIA INGESTION

$$\text{DOS}\ \frac{\text{rad}}{} = \text{ER}\ \frac{\text{mR}}{\text{h}} \times \text{DEPNO}\ \frac{\mu\text{Ci/m}^2}{\text{mR/h}} \times \text{INDEP}\ \frac{\mu\text{Ci}}{\mu\text{Ci/m}^2} \times \text{DF}\ \frac{\text{rad}}{\mu\text{Ci}}$$

ER	Event, location
DEPNO	Nuclide, event, time of arrival (TOA)
INDEP	Individual, nuclide, event
DF	Nuclide, organ, age group
DOS	Individual, event, nuclide, organ

DOSE ESTIMATES FOR LITIGANTS VIA INGESTION

$$DOS = ER \times DEPNO \times INDEP \times DF$$

$$\text{rad} \quad \frac{\text{mR}}{\text{h}} \quad \frac{\mu\text{Ci/m}^2}{\text{mR/h}} \quad \frac{\mu\text{Ci}}{\mu\text{Ci/m}^2} \quad \frac{\text{rad}}{\mu\text{Ci}}$$

INPUT:

- Birthdates
- Event dates
- INDEP values for events
- Residence locations and dates
- ER and TOA for events and locations

CALCULATIONS:

- Select DEPNO and DF for each event
- Compute doses
- Sum over nuclides and events

PRIVACY ACT MATERIAL REMOVED

INTERNAL DOSE ESTIMATES VIA INGESTION FOR LITIGANTS (RADS)

ORGAN	UNCLE	TS-EASY	TS-FOX	ANNIE	NANCY	SIMON	HARRY	GRABLE	TESLA	TURK	HORNET	BEE
BON SURF	0.	0.	0.	7.45E-03	0.	5.19E-04	1.22E-01	0.	1.20E-03	0.	0.	0.
BREAST	0.	0.	0.	1.65E-03	0.	1.06E-04	3.20E-02	0.	4.43E-04	0.	0.	0.
LLI WALL	0.	0.	0.	2.93E-02	0.	1.44E-03	4.64E-01	0.	6.95E-03	0.	0.	0.
KIDNEYS	0.	0.	0.	2.12E-03	0.	1.32E-04	4.16E-02	0.	5.67E-04	0.	0.	0.
LIVER	0.	0.	0.	2.36E-03	0.	1.44E-04	4.69E-02	0.	6.25E-04	0.	0.	0.
LUNGS	0.	0.	0.	1.47E-03	0.	9.69E-05	2.87E-02	0.	3.97E-04	0.	0.	0.
OVARIES	0.	0.	0.	2.06E-03	0.	1.16E-04	3.27E-02	0.	5.37E-04	0.	0.	0.
R MARROW	0.	0.	0.	5.62E-03	0.	3.07E-04	9.20E-02	0.	1.01E-03	0.	0.	0.
THYROID	0.	0.	0.	7.53E-01	0.	7.62E-02	3.60E+01	0.	2.17E-01	0.	0.	0.
TOTAL BODY	0.	0.	0.	3.01E-03	0.	2.13E-04	6.25E-02	0.	7.07E-04	0.	0.	0.
UTERUS	0.	0.	0.	1.52E-03	0.	9.20E-05	2.43E-02	0.	3.91E-04	0.	0.	0.
BLAD WAL	0.	0.	0.	1.41E-03	0.	8.61E-05	2.22E-02	0.	3.63E-04	0.	0.	0.

ORGAN	APPLE I	MET	APPLE II	ZUCCHINI	WILSON	PRISCILLA	HOOD	DIABLO	KEPLER	SHASTA	SMOKY	NEWTON
BON SURF	0.	0.	0.	3.14E-03	0.	0.	0.	0.	0.	0.	3.75E-03	0.
BREAST	0.	0.	0.	7.73E-04	0.	0.	0.	0.	0.	0.	1.27E-03	0.
LLI WALL	0.	0.	0.	9.41E-03	0.	0.	0.	0.	0.	0.	2.17E-02	0.
KIDNEYS	0.	0.	0.	1.01E-03	0.	0.	0.	0.	0.	0.	1.58E-03	0.
LIVER	0.	0.	0.	1.11E-03	0.	0.	0.	0.	0.	0.	1.66E-03	0.
LUNGS	0.	0.	0.	6.95E-04	0.	0.	0.	0.	0.	0.	1.12E-03	0.
OVARIES	0.	0.	0.	7.60E-04	0.	0.	0.	0.	0.	0.	1.00E-03	0.
R MARROW	0.	0.	0.	2.36E-03	0.	0.	0.	0.	0.	0.	2.90E-03	0.
THYROID	0.	0.	0.	8.60E-01	0.	0.	0.	0.	0.	0.	2.13E+00	0.
TOTAL BODY	0.	0.	0.	1.53E-03	0.	0.	0.	0.	0.	0.	2.40E-03	0.
UTERUS	0.	0.	0.	5.79E-04	0.	0.	0.	0.	0.	0.	8.30E-04	0.
BLAD WAL	0.	0.	0.	5.31E-04	0.	0.	0.	0.	0.	0.	7.54E-04	0.

ORGAN	WHITNEY	MORGAN	OTERO	EDDY	SMALL BOY	PIKE	PIN STRIPE	TOTAL
BON SURF	0.	0.	0.	0.	0.	0.	0.	1.38E-01
BREAST	0.	0.	0.	0.	0.	0.	0.	3.62E-02
LLI WALL	0.	0.	0.	0.	0.	0.	0.	5.33E-01
KIDNEYS	0.	0.	0.	0.	0.	0.	0.	4.69E-02
LIVER	0.	0.	0.	0.	0.	0.	0.	5.10E-02
LUNGS	0.	0.	0.	0.	0.	0.	0.	3.25E-02
OVARIES	0.	0.	0.	0.	0.	0.	0.	3.72E-02
R MARROW	0.	0.	0.	0.	0.	0.	0.	1.04E-01
THYROID	0.	0.	0.	0.	0.	0.	0.	4.00E+01
TOTAL BODY	0.	0.	0.	0.	0.	0.	0.	7.04E-02
UTERUS	0.	0.	0.	0.	0.	0.	0.	2.70E-02
BLAD WAL	0.	0.	0.	0.	0.	0.	0.	2.63E-02

PRIVACY ACT MATERIAL REMOVED

Dose via Ingestion

SHOT NAME IS HARRY

DOSE IN RAD

NUCLIDE	BON SURF	BREAST	LLI WALL	KIDNEYS	LIVER	LUNGS	OVARIES	R MARROW	TESTES	THYROID	TOT BODY	UTERUS	BLAD WAL
NP239	2.14E-03	2.37E-04	1.19E-01	2.87E-04	7.64E-04	3.76E-05	2.23E-03	7.90E-04	1.82E-04	3.89E-06	7.80E-04	9.41E-04	6.49E-04
SR 89	5.46E-02	2.62E-03	7.22E-02	3.44E-03	3.44E-03	2.62E-03	3.44E-03	3.70E-02	3.44E-03	3.44E-03	1.04E-02	3.44E-03	3.44E-03
SR 90	2.77E-02	2.52E-04	1.80E-03	3.85E-04	3.88E-04	2.52E-04	3.95E-04	2.01E-02	3.85E-04	3.85E-04	6.37E-03	3.85E-04	3.85E-04
SR 91	4.15E-04	2.61E-04	1.00E-02	3.47E-04	2.12E-04	1.60E-04	5.43E-04	5.65E-04	2.04E-04	1.26E-04	7.54E-04	6.33E-04	1.99E-04
Y 93	0.	0.	2.44E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZR 97	1.22E-04	2.17E-04	4.79E-02	2.94E-04	2.13E-04	4.72E-05	1.66E-03	3.48E-04	1.39E-04	7.12E-06	5.20E-04	7.56E-04	4.72E-04
MO 99	5.80E-03	1.60E-03	9.77E-03	2.05E-02	2.32E-02	1.69E-03	2.50E-03	4.02E-03	1.94E-03	2.20E-03	2.35E-03	2.30E-03	2.14E-03
RU103	3.73E-04	4.67E-04	8.07E-03	5.09E-04	4.71E-04	2.83E-04	7.08E-04	6.43E-04	4.74E-04	2.43E-04	8.30E-04	3.29E-04	2.74E-04
RH105	1.95E-05	7.53E-06	2.21E-03	8.23E-06	6.55E-06	9.44E-07	4.27E-05	1.11E-05	5.65E-06	6.51E-06	1.99E-05	1.86E-05	1.02E-05
RU106	1.31E-03	1.32E-03	1.58E-02	1.04E-03	1.32E-03	1.30E-03	1.50E-03	1.34E-03	1.32E-03	1.29E-03	1.84E-03	1.39E-03	1.37E-03
I131	7.50E-03	1.04E-02	1.23E-03	1.26E-03	1.45E-03	8.77E-03	1.18E-03	8.12E-03	1.09E-03	3.18E+01	2.22E-02	1.24E-03	1.18E-03
TE132	8.64E-03	3.65E-03	6.57E-03	2.90E-03	2.96E-03	3.45E-03	5.65E-03	4.64E-03	3.79E-03	6.21E-01	3.45E-03	8.00E-04	7.29E-04
I133	1.52E-03	1.78E-03	1.45E-03	1.49E-03	1.47E-03	1.73E-03	1.33E-03	1.61E-03	1.36E-03	3.46E+00	2.83E-03	1.40E-03	1.38E-03
I135	2.09E-04	2.39E-04	2.44E-04	2.53E-04	2.37E-04	2.33E-04	2.24E-04	2.27E-04	1.99E-04	1.11E-01	3.13E-04	2.39E-04	2.21E-04
CS136	7.14E-04	6.99E-04	8.94E-04	8.31E-04	8.28E-04	6.89E-04	7.14E-04	7.77E-04	7.99E-04	7.21E-04	6.77E-04	1.01E-03	9.10E-04
CS137	6.63E-03	6.72E-03	7.80E-03	7.42E-03	7.37E-03	6.68E-03	7.00E-03	7.16E-03	7.54E-03	6.83E-03	7.59E-03	7.80E-03	7.64E-03
BA140	3.91E-03	1.47E-03	7.66E-02	4.65E-04	9.94E-04	5.29E-04	2.86E-03	4.16E-03	1.96E-03	1.10E-03	8.50E-04	1.39E-03	1.08E-03
CE143	2.69E-05	3.87E-05	1.96E-02	4.67E-05	3.65E-05	6.38E-06	3.54E-04	8.47E-05	2.56E-05	7.29E-07	4.10E-04	1.43E-04	9.31E-05
CE144	3.00E-05	2.86E-06	1.56E-02	8.79E-06	5.03E-04	1.52E-06	1.84E-05	2.09E-05	2.39E-06	4.87E-06	1.90E-04	7.19E-06	5.69E-06
ND147	2.74E-05	3.13E-05	2.29E-02	3.52E-05	2.76E-05	4.32E-06	3.21E-04	8.77E-05	2.44E-05	4.75E-07	1.30E-04	1.22E-04	2.96E-05
TOTAL	1.22E-01	3.20E-02	4.64E-01	4.15E-02	4.59E-02	2.87E-02	3.27E-02	9.20E-02	2.49E-02	3.80E+01	8.25E-02	2.43E-02	2.22E-02

FRACTION OF TOTAL

NP239	1.75E-02	7.40E-03	2.57E-01	6.91E-03	1.67E-02	1.31E-03	6.83E-02	8.59E-03	7.32E-03	1.08E-07	1.28E-02	3.87E-02	2.92E-02
SR 89	4.46E-01	8.18E-02	1.56E-01	8.28E-02	7.49E-02	9.13E-02	1.05E-01	4.05E-01	1.38E-01	9.55E-05	1.67E-01	1.41E-01	1.55E-01
SR 90	2.26E-01	7.86E-03	3.87E-03	9.29E-03	8.45E-03	8.77E-03	1.18E-02	2.19E-01	1.55E-02	1.07E-05	1.02E-01	1.58E-02	1.74E-02
SR 91	3.40E-03	8.15E-03	2.16E-02	8.37E-03	4.63E-03	5.57E-03	1.66E-02	6.14E-03	8.19E-03	3.51E-08	1.21E-02	2.60E-02	8.95E-03
Y 93	0.	0.	5.26E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZR 97	9.98E-04	6.78E-03	1.03E-01	7.09E-03	4.64E-03	1.65E-03	5.09E-02	3.78E-03	5.60E-03	1.98E-07	8.32E-03	3.11E-02	2.13E-02
MO 99	4.76E-02	4.98E-02	2.11E-02	4.93E-01	5.06E-01	5.88E-02	7.66E-02	4.38E-02	7.80E-02	6.11E-05	3.78E-02	9.44E-02	9.63E-02
RU103	3.06E-03	1.46E-02	1.74E-02	1.23E-02	1.03E-02	9.86E-03	2.17E-02	6.99E-03	1.91E-02	6.74E-06	1.93E-02	1.35E-02	1.23E-02
RH105	1.60E-04	2.35E-04	4.77E-03	1.98E-04	1.43E-04	3.29E-05	1.31E-03	1.21E-04	2.27E-04	2.37E-07	3.19E-04	7.65E-04	4.60E-04
RU106	1.07E-02	4.12E-02	3.40E-02	2.50E-02	2.87E-02	4.54E-02	4.59E-02	1.45E-02	5.32E-02	3.58E-05	2.94E-02	5.71E-02	6.18E-02
I131	6.15E-02	3.25E-01	2.64E-03	3.04E-02	3.15E-02	3.06E-01	3.61E-02	8.83E-02	4.39E-02	8.83E-01	3.66E-01	6.10E-02	5.32E-02
TE132	7.09E-02	1.14E-01	1.41E-02	7.00E-02	6.45E-02	1.20E-01	1.73E-01	5.04E-02	1.52E-01	1.73E-02	6.63E-02	3.29E-02	3.29E-02
I133	1.25E-02	5.57E-02	3.13E-03	3.59E-02	3.20E-02	6.02E-02	4.08E-02	1.75E-02	5.45E-02	9.61E-02	4.52E-02	6.76E-02	6.21E-02
I135	1.71E-03	7.47E-03	5.25E-04	6.10E-03	5.17E-03	8.12E-03	6.86E-03	2.46E-03	7.98E-03	3.00E-03	5.01E-03	4.83E-03	9.94E-03
CS136	5.86E-03	2.18E-02	1.93E-03	2.00E-02	1.80E-02	2.40E-02	2.19E-02	8.45E-03	3.21E-02	2.00E-05	1.08E-02	4.15E-02	4.10E-02
CS137	5.61E-02	2.10E-01	1.68E-02	1.79E-01	1.61E-01	2.40E-01	2.14E-01	7.79E-02	3.03E-01	1.90E-04	1.21E-01	3.20E-01	3.44E-01
BA140	3.21E-02	4.60E-02	1.65E-01	1.12E-02	2.17E-02	1.84E-02	8.76E-02	4.52E-02	7.87E-02	3.06E-05	1.38E-02	5.70E-02	4.89E-02
CE143	2.21E-04	1.21E-03	4.21E-02	1.13E-03	7.95E-04	2.23E-04	1.08E-02	9.21E-04	1.03E-03	2.03E-06	6.57E-03	5.87E-03	4.19E-03
CE144	2.46E-04	8.93E-05	3.35E-02	2.12E-04	1.10E-02	5.32E-05	5.01E-04	2.27E-04	9.62E-05	1.38E-07	3.04E-03	2.96E-04	2.56E-04
ND147	2.25E-04	9.78E-04	4.93E-02	8.49E-04	6.01E-04	1.51E-04	9.83E-03	9.54E-04	9.82E-04	1.32E-06	2.08E-03	5.03E-03	1.33E-03

PRIVACY ACT MATERIAL REMOVED

LITIGANT: **AGE GROUP:** **CHILD**

EVENT: **HARRY** **DIAGNOSIS:** **THYROID CANCER**

RESIDENCE: **ST. GEORGE** **THYROID DOSE:** **36 RAD**

Percent of total dose

	LLI	Red Marrow	Thyroid
Np-239	25.7		
Sr-89	15.8	40.5	
Sr-90		21.9	
Sr-91	2.2		
Y-93	5.3		
Zr-97	10.3		
Mo-99	2.1	4.4	
Ru-103	1.7		
Ru-106	3.4	1.5	
I-131		8.8	88.3
Te-132	1.4	5.0	1.7
I-133		1.8	9.6
Cs-137	1.7	7.8	
Ba-140	16.5	4.5	
Ce-143	4.2		
Ce-144	3.4		
Nd-147	4.9		

PRIVACY ACT MATERIAL REMOVED

LITIGANT: **AGE GROUP:** CHILD

EVENT: ALL (6 OF 31) **DIAGNOSIS:** THYROID CANCER

RESIDENCE: ST. GEORGE **THYROID DOSE:** 40 RAD

Percent of total dose

	LLI	Red Marrow	Thyroid
Np-239	24.4		
Sr-89	15.8	40.5	
Sr-90		21.8	
Sr-91	2.1		
Y-93	5.1		
Zr-97	10.0		
Mo-99	2.1	4.3	
Ru-103	1.9		
Ru-106	3.5	1.5	
I-131		8.7	88.5
Te-132	1.5	5.0	1.8
I-133		1.7	9.4
Cs-137	1.7	8.0	
Ba-140	17.5	4.7	
Ce-143	4.2		
Ce-144	3.4		
Nd-147	5.2		

PRIVACY ACT MATERIAL REMOVED

INTERNAL DOSE ESTIMATES VIA INGESTION FOR LITIGANTS (RADS)

ORGAN	UNCLE	TS-EASY	TS-FOX	ANNIE	NANCY	SIMON	HARRY	GRABLE	TESLA	TURK	HORNET	BEE
BON SURF	0.	0.	0.	6.61E-03	0.	1.16E-03	1.32E-01	0.	9.41E-04	0.	0.	0.
BREAST	0.	0.	0.	1.43E-03	0.	2.20E-04	3.56E-02	0.	3.20E-04	0.	0.	0.
LLI WALL	0.	0.	0.	1.94E-02	0.	2.16E-03	3.00E-01	0.	4.15E-03	0.	0.	0.
KIDNEYS	0.	0.	0.	1.00E-03	0.	2.54E-04	4.03E-02	0.	4.06E-04	0.	0.	0.
LIVER	0.	0.	0.	1.95E-03	0.	2.72E-04	4.40E-02	0.	4.46E-04	0.	0.	0.
LUNGS	0.	0.	0.	1.33E-03	0.	2.14E-04	3.24E-02	0.	3.03E-04	0.	0.	0.
R MARROW	0.	0.	0.	5.00E-03	0.	0.72E-04	1.01E-01	0.	7.40E-04	0.	0.	0.
TESTES	0.	0.	0.	1.46E-03	0.	2.01E-04	2.50E-02	0.	3.22E-04	0.	0.	0.
THYROID	0.	0.	0.	5.26E-01	0.	1.04E-01	4.07E+01	0.	1.40E-01	0.	0.	0.
TOTAL BODY	0.	0.	0.	2.65E-03	0.	4.01E-04	7.22E-02	0.	6.19E-04	0.	0.	0.
BLAD WAL	0.	0.	0.	1.32E-03	0.	1.91E-04	2.36E-02	0.	2.07E-04	0.	0.	0.

ORGAN	APPLE I	MET	APPLE II	ZUCCHINI	WILSON	PRISCILLA	HOOD	DIABLO	KEPLER	SHASTA	SMOKY	NEWTON
BON SURF	0.	0.	0.	2.00E-03	0.	0.	0.	0.	0.	0.	7.90E-03	0.
BREAST	0.	0.	0.	5.10E-04	0.	0.	0.	0.	0.	0.	2.79E-03	0.
LLI WALL	0.	0.	0.	4.00E-03	0.	0.	0.	0.	0.	0.	3.05E-02	0.
KIDNEYS	0.	0.	0.	5.96E-04	0.	0.	0.	0.	0.	0.	3.20E-03	0.
LIVER	0.	0.	0.	6.46E-04	0.	0.	0.	0.	0.	0.	3.43E-03	0.
LUNGS	0.	0.	0.	4.73E-04	0.	0.	0.	0.	0.	0.	2.48E-03	0.
R MARROW	0.	0.	0.	1.56E-03	0.	0.	0.	0.	0.	0.	6.17E-03	0.
TESTES	0.	0.	0.	3.70E-04	0.	0.	0.	0.	0.	0.	1.43E-03	0.
THYROID	0.	0.	0.	6.97E-01	0.	0.	0.	0.	0.	0.	5.00E+00	0.
TOTAL BODY	0.	0.	0.	1.07E-03	0.	0.	0.	0.	0.	0.	5.49E-03	0.
BLAD WAL	0.	0.	0.	3.47E-04	0.	0.	0.	0.	0.	0.	1.55E-03	0.

ORGAN	WHITNEY	MORGAN	OTERO	EDDY	SMALL BOY	PIKE	PIN STRIPE	TOTAL
BON SURF	0.	0.	0.	0.	0.	0.	0.	1.50E-01
BREAST	0.	0.	0.	0.	0.	0.	0.	4.09E-02
LLI WALL	0.	0.	0.	0.	0.	0.	0.	3.76E-01
KIDNEYS	0.	0.	0.	0.	0.	0.	0.	4.67E-02
LIVER	0.	0.	0.	0.	0.	0.	0.	5.07E-02
LUNGS	0.	0.	0.	0.	0.	0.	0.	3.72E-02
R MARROW	0.	0.	0.	0.	0.	0.	0.	1.15E-01
TESTES	0.	0.	0.	0.	0.	0.	0.	2.80E-02
THYROID	0.	0.	0.	0.	0.	0.	0.	5.53E+01
TOTAL BODY	0.	0.	0.	0.	0.	0.	0.	8.24E-02
BLAD WAL	0.	0.	0.	0.	0.	0.	0.	2.73E-02

PRIVACY ACT MATERIAL REMOVED

Dose via Ingestion

TOTAL DOSE IN RADS

NUCLIDE	BON SURF	BREAST	LLI WALL	KIDNEYS	LIVER	LUNGS	OVARIES	R MARROW	TESTES	THYROID	TOT BODY	UTERUS	BLAD WAL
NP239	1.21E-03	1.34E-04	6.73E-02	1.62E-04	4.32E-04	2.12E-05	1.26E-03	4.46E-04	1.03E-04	2.20E-06	4.41E-04	5.32E-04	3.87E-04
SR 89	6.83E-02	3.28E-03	9.57E-02	4.23E-03	4.23E-03	3.28E-03	4.23E-03	4.67E-02	4.23E-03	4.23E-03	1.29E-02	4.23E-03	4.23E-03
SR 90	3.86E-02	3.50E-04	2.51E-03	5.25E-04	5.31E-04	3.50E-04	5.25E-04	2.80E-02	5.25E-04	5.25E-04	8.86E-03	5.25E-04	5.25E-04
SR 91	2.20E-04	1.39E-04	5.74E-03	1.84E-04	1.17E-04	8.48E-05	3.11E-04	3.00E-04	1.08E-04	6.70E-05	4.00E-04	3.36E-04	1.14E-04
Y 93	0.	0.	1.38E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZR 97	7.00E-05	1.25E-04	2.76E-02	1.69E-04	1.23E-04	2.72E-05	9.87E-04	2.00E-04	8.02E-05	4.10E-06	2.89E-04	4.35E-04	2.72E-04
MO 99	6.02E-03	1.64E-03	1.10E-02	2.11E-02	2.38E-02	1.73E-03	2.52E-03	4.17E-03	1.95E-03	2.22E-03	2.41E-03	2.31E-03	2.15E-03
RU103	2.76E-04	3.48E-04	6.35E-03	3.79E-04	3.52E-04	2.11E-04	5.56E-04	4.79E-04	3.53E-04	1.81E-04	6.15E-04	2.59E-04	2.15E-04
RH105	1.53E-05	6.44E-06	1.89E-03	7.03E-06	5.59E-06	8.07E-07	3.65E-05	9.51E-06	4.83E-06	6.66E-06	1.70E-05	1.59E-05	8.72E-06
RU106	1.20E-03	1.21E-03	1.49E-02	9.53E-04	1.21E-03	1.19E-03	1.38E-03	1.22E-03	1.21E-03	1.18E-03	1.68E-03	1.27E-03	1.26E-03
I131	1.10E-02	1.64E-02	1.92E-03	1.98E-03	2.27E-03	1.38E-02	1.84E-03	1.28E-02	1.70E-03	5.00E+01	3.49E-02	1.94E-03	1.84E-03
TE132	5.93E-03	2.53E-03	5.44E-03	2.65E-03	2.09E-03	2.38E-03	3.91E-03	3.21E-03	2.62E-03	4.28E-01	2.39E-03	6.63E-04	6.04E-04
I133	2.07E-03	2.42E-03	1.98E-03	2.03E-03	2.00E-03	2.34E-03	1.82E-03	2.19E-03	1.85E-03	4.69E+00	3.84E-03	1.91E-03	1.88E-03
I135	2.37E-04	2.71E-04	2.77E-04	2.87E-04	2.69E-04	2.64E-04	2.84E-04	2.87E-04	2.25E-04	1.26E-01	3.55E-04	2.71E-04	2.50E-04
CS136	1.05E-03	1.03E-03	1.31E-03	1.22E-03	1.21E-03	1.01E-03	1.05E-03	1.14E-03	1.17E-03	1.06E-03	9.93E-04	1.48E-03	1.33E-03
CS137	1.00E-02	9.88E-03	1.15E-02	1.09E-02	1.08E-02	1.01E-02	1.03E-02	1.05E-02	1.11E-02	1.00E-02	1.12E-02	1.15E-02	1.12E-02
BA140	3.08E-03	1.16E-03	6.59E-02	4.00E-04	7.95E-04	4.18E-04	2.46E-03	3.27E-03	1.55E-03	8.69E-04	7.31E-04	1.19E-03	9.33E-04
CE143	1.09E-05	2.43E-05	1.22E-02	2.93E-05	2.28E-05	4.00E-06	2.22E-04	5.30E-05	1.60E-05	4.56E-07	2.57E-04	8.94E-05	5.83E-05
CE141	2.60E-05	2.47E-06	1.35E-02	7.31E-06	4.17E-04	1.32E-06	1.42E-05	1.81E-05	2.07E-06	4.09E-06	1.64E-04	6.22E-06	4.93E-06
ND147	1.07E-05	2.14E-05	1.56E-02	2.41E-05	1.88E-05	2.95E-06	2.19E-04	5.99E-05	1.67E-05	3.24E-07	8.89E-05	8.36E-05	2.02E-05
TOTAL	1.50E-01	4.09E-02	3.76E-01	4.67E-02	5.07E-02	3.72E-02	3.38E-02	1.15E-01	2.88E-02	5.53E+01	8.24E-02	2.90E-02	2.73E-02

FRACTION OF TOTAL

NP239	8.04E-03	3.27E-03	1.79E-01	3.47E-03	8.52E-03	5.70E-04	3.73E-02	3.88E-03	3.57E-03	3.97E-08	5.35E-03	1.83E-02	1.34E-02
SR 89	4.55E-01	8.02E-02	2.54E-01	9.00E-02	8.35E-02	8.81E-02	1.25E-01	4.06E-01	1.47E-01	7.66E-05	1.56E-01	1.46E-01	1.55E-01
SR 90	2.57E-01	8.55E-03	6.66E-03	1.12E-02	1.05E-02	9.39E-03	1.55E-02	2.43E-01	1.82E-02	9.50E-06	1.08E-01	1.81E-02	1.92E-02
SR 91	1.46E-03	3.39E-03	1.52E-02	3.96E-03	2.31E-03	2.28E-03	9.18E-03	2.61E-03	3.76E-03	1.21E-06	4.86E-03	1.16E-02	4.16E-03
Y 93	0.	0.	3.68E-02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZR 97	4.66E-04	3.06E-03	7.33E-02	3.63E-03	2.42E-03	7.29E-04	2.83E-02	1.74E-03	2.78E-03	7.41E-08	3.63E-03	1.50E-02	9.95E-03
MO 99	4.01E-02	4.00E-02	2.92E-02	4.52E-01	4.69E-01	4.64E-02	7.43E-02	3.63E-02	6.77E-02	4.02E-05	2.92E-02	7.96E-02	7.87E-02
RU103	1.85E-03	8.50E-03	1.69E-02	8.12E-03	6.93E-03	5.67E-03	1.64E-02	4.17E-03	1.23E-02	3.27E-06	7.48E-03	8.92E-03	7.88E-03
RH105	1.02E-04	1.57E-04	5.02E-03	1.51E-04	1.10E-04	2.17E-05	1.08E-03	8.27E-05	1.68E-04	1.21E-07	2.07E-04	5.48E-04	3.20E-04
RU106	7.97E-03	2.95E-02	3.95E-02	2.04E-02	2.38E-02	3.20E-02	4.07E-02	1.07E-02	4.21E-02	2.14E-06	2.04E-02	4.39E-02	4.61E-02
I131	7.85E-02	4.00E-01	5.09E-03	4.25E-02	4.48E-02	3.71E-01	5.43E-02	1.11E-01	5.91E-02	9.05E-01	4.23E-01	6.67E-02	6.76E-02
TE132	3.98E-02	6.18E-02	1.45E-02	4.39E-02	4.11E-02	6.40E-02	1.16E-01	2.79E-02	9.10E-02	7.75E-03	2.90E-02	2.28E-02	2.21E-02
I133	1.38E-02	5.91E-02	5.27E-03	4.36E-02	3.95E-02	6.29E-02	5.38E-02	1.91E-02	6.42E-02	8.49E-02	4.65E-02	6.59E-02	6.88E-02
I135	1.58E-03	6.63E-03	7.35E-04	6.15E-03	5.30E-03	7.09E-03	7.51E-03	2.24E-03	7.82E-03	2.27E-03	4.31E-03	9.35E-03	9.18E-03
CS136	6.97E-03	2.51E-02	3.48E-03	2.61E-02	2.39E-02	2.71E-02	3.10E-02	9.92E-03	4.07E-02	1.91E-05	1.20E-02	5.11E-02	4.89E-02
CS137	6.69E-02	2.41E-01	3.05E-02	2.34E-01	2.14E-01	2.72E-01	3.04E-01	9.16E-02	3.85E-01	1.82E-04	1.35E-01	3.95E-01	4.11E-01
BA140	2.05E-02	2.84E-02	1.75E-01	8.57E-03	1.57E-02	1.12E-02	7.27E-02	2.84E-02	5.37E-02	1.57E-05	8.87E-03	4.11E-02	3.42E-02
CE143	1.12E-04	5.93E-04	3.25E-02	6.27E-04	4.50E-04	1.07E-04	6.56E-03	4.61E-04	5.56E-04	8.26E-09	3.12E-03	3.08E-03	2.13E-03
CE144	1.73E-04	6.05E-05	3.58E-02	1.57E-04	8.22E-03	3.54E-05	4.18E-04	1.57E-04	7.19E-05	7.40E-08	2.00E-03	2.14E-04	1.81E-04
ND147	1.25E-04	5.23E-04	4.15E-02	5.16E-04	3.71E-04	7.93E-05	6.48E-03	5.21E-04	5.79E-04	8.87E-09	1.08E-03	2.88E-03	7.41E-04

PRIVACY ACT MATERIAL REMOVED

LITIGANT: ..... **AGE GROUP:** CHILD

EVENT: ALL (6 OF 31) **DIAGNOSIS:** LEUKEMIA

RESIDENCE: WASHINGTON **R MARROW DOSE:** 120 mrad

Percent of total dose

	LLI	Red Marrow	Thyroid
Np-239	17.9		
Sr-89	25.4	40.6	
Sr-90		24.3	
Sr-91	1.5		
Y-93	3.7		
Zr-97	7.3		
Mo-99	2.9	3.8	
Ru-103	1.7		
Ru-106	4.0	1.1	
I-131		11.1	90.5
Te-132	1.5	2.8	
I-133		1.9	8.5
Cs-137	3.1	9.2	
Ba-140	17.5	2.8	
Ce-143	3.3		
Ce-144	3.6		
Nd-147	4.2		

PRIVACY ACT MATERIAL REMOVED

IN UTERO EXPOSURES

Litigant	Birthdate	Residence	Event	Event date
	/52	Cedar City	TS-FOX	5/25/52
	'53	Cedar City	HARRY	5/17/53
	/55	St. George	ZUCCHINI	5/15/55

PRIVACY ACT MATERIAL REMOVED

FETAL DOSES (RAD)

Litigant	Thyroid	Total body (and other organs)
	<0.08	0.0003 - 0.0004
	<0.5	0.002 - 0.003
	<0.2	0.001

CONCENTRATION OF IODINE BY HUMAN EXTRATHYROIDAL IODIDE CONCENTRATING (ETIC) TISSUES

Fluid-to-plasma ratio

	Average	Range	Reference
Saliva	48	12 - 211	Honour (1952)
	63	42 - 101	Jaimet et al. (1956)
	48 (est.)	10 - 85	Schiff et al. (1947)
Gastric juice	33	15 - 84	Honour (1952)
Milk	24	11 - 36	Honour (1952)
	28		Miller & Weetch (1955)

ESTIMATION OF DOSE TO ETIC TISSUES FROM I-131

- Half life in ECF (ICRP-10)

  T_{B1} = 0.35d

  T_{E1} = 0.335d $\lambda_{E1} = 2.07 d^{-1}$

- Time integral of concentrations

  ECF

  TI = $0.7/(2.7 \times 10^4 ml \times 2.07 d^{-1})$

  = 1.25×10^{-5} d/ml

  Fluids concentrated from ECF, and ETIC tissues

  TI = 1.25×10^{-5} R d/ml or d/g

  R = fluid-to-plasma ratio

- Dose factor for ETIC tissues

  DF = 1.25×10^{-5} R d/g × 0.2 MeV

  × 51.2 rad per (μCi-d/g)-MeV

  = 1.3×10^{-4} R rad/μCi

ESTIMATION OF I-131 DOSE TO LACTATING BREAST

- Recovery in milk
  - 0.03 - 26.8% (Weaver and Dobson, 1960)
  - ≤10% (Chiba and Ichikawa, 1968)

- Transfer coefficient and time integral
  - f_M = 0.1 d/l
  - TI = 10^{-4} d/ml

- Assume equivalence of time integrals
  - TI = 10^{-4} d/g

- Dose factor
  - DF = 10^{-4} d/g × 0.2 MeV × 51.2 rad per (μCi-d/g)-MeV
  - = 1.0×10^{-3} rad/μCi

COMPARISON OF ADULT DOSE FACTORS FOR I-131

DF, rad/μCi

	LLNL	MIRD	ICRP-30
Thyroid	1.9	1.3	1.8
Breast	4.5(-4)		4.5(-4)
Lactating breast	1(-3)		
	3(-3)		
Salivary	7(-3)		
Stomach	4(-3)	1.4(-3)	1.1(-3)
Thymus			1.1(-3)
Total body	9.6(-4)	7.1(-4)	9.1(-4)

Note: 1(-3) signifies 1×10^{-3}

ESTIMATED DOSE TO HYPOTHETICAL ADULT FEMALE FROM I-131 IN ETIC TISSUES

Total dose, rad

	Calculated value	From ETIC tissues
Breast	0.024	0.012
LLI wall	0.54	
Liver	0.035	
R marrow	0.066	
Salivary		0.029
Thyroid	9.9	
Total body	0.041	

DR. ANSPAUGH: Could I have the first viewgraph? (LRA-19). This is just to reemphasize what Dr. Ng mentioned about the calculation of the dose from ingestion, which was the subject of his presentation.

It's basically the multiplication of these four terms, and the next thing that was to be considered was the estimate of uncertainty; and speaking specifically about the litigants, we were in a position at the time that we made the calculations for the litigants of not having the input from Dr. Whicker's model in terms of his estimate of uncertainty. So we estimated the uncertainty in these estimates based upon a somewhat different approach. That's shown in the next viewgraph.

(LRA-20). We made the assumption, which is quite reasonably justified on the basis of other studies reported in the literature, that all of these factors were lognormally distributed; and we estimated their dispersion, or their geometric standard deviation, as shown on this slide. Now the measurements of mR/hr, 1.5 is a reasonable, fairly conservative number of the actual calculated geometric standard deviations that we got from the DRI folks when they looked at locations which had more than one d/measurement of mR/hr at a particular location. This is our source term number. For the purposes of this calculation at the time, we assumed that that number was exactly known. In other words, that we did, in fact, know how to calculate exactly the deposition of a particular radionuclide per unit of external exposure rate. Now that is not quite true. As we go through in a little more sophisticated method, we will examine the actual variations in that term.

Now this is the one that really drives the uncertainty, the transport through the food chain. On the basis of some work done by people at Oak Ridge, Hoffman and Baes in particular, they looked at radioiodine transport through a food chain, through the cow milk food chain. Their estimate of

the geometric standard deviation was essentially 2.0. So that we assume then that all radionuclides behaved in that kind of manner in terms of their dispersion. Now you may recall from the results that the Colorado State group presented yesterday, this turns out to be quite well confirmed by their numbers. As I recall their actual calculations of geometric standard deviations varied from 1.5 to 2.0. The variation in the dose factor -- this again comes from studies at Oak Ridge where they have carefully examined the data available for radioiodine in particular, and also for Cesium-137, and this takes into account variations in uptake factors, biological turnover rates, size of the organ, and so forth. Their data indicate that 1.8 is the geometric standard deviation for that factor. These are all summed up, according to this expression. We take the logarithm of this number, since it is the logarithms that are normally distributed, sum them up in the usual way, take the square root and exponentiate it. So that our overall estimated geometric standard deviation for these calculations of dose from ingestion is 2.7. Then if we want to calculate an arithmetic mean, or look at the relationship between arithmetic and geometric means, we can do so with this calculation. For this particular geometric standard deviation, the arithmetic mean is 1.6 times the geometric mean. So that is the process that we used for the calculations for the litigants to estimate the uncertainty in the absence of the dispersion of the results from our own models.

Moving on to the next viewgraph (LRA-21), we look at the calculations of the dose from inhalation. We did do this for the litigants in some detail, as I will indicate later on. This is our standard method of the calculation. This is a measured air concentration. All results that we calculated were based upon measured air concentrations, perhaps at a location in the nearest town as opposed to that town; but, nevertheless,

they were based upon measured air concentrations. That measurement gives you a total $\mu Ci/m^3$. Then you multiply by the length of the sampling in hours; multiply by a breathing rate which is age specific, of course. Then we want to calculate for a particular radionuclide. We go back to Harry Hicks' source term calculations. For any radionuclide, we can look at the ratio of that radionuclide to the total activity; then that multiplied by this, of course, then gives us the activity of a particular radionuclide; and then, again, our dose factor. Again it depends on human metabolism and is an age specific number.

Well, the key thing here is then this measured air concentrations, and the next viewgraph (LRA-22) we've gone through before. Our preference is to use data collected by this device, which is a Casella cascade impactor. It has four stages followed by an after-filter so that we typically were able to recover data as shown in the next viewgraph (LRA-23) where we have the raw log sheets from Los Alamos now where we have the count data for each one of these five stages. We have actually gone back to this original data to make our calculations.

Now the problem with this data, or one problem with this data, is that what is shown here in terms of the diameters is not an aerodynamic diameter that we want to enter the ICRP lung dynamics model with; so we have gone through and recalculated these diameters.

If I could have the next viewgraph (LRA-24). This is again some of the raw data that we find in the files from Los Alamos. This is their original trace of the activity and their attempt to fit. This one was calculated out to have a median diameter of 42 microns. We have found some errors in their calculation. It makes slight corrections. It has a dramatic change on some of these numbers. We get our calculation of 18. But, nevertheless, as I indicated, we have found more accurate calibration

data for these cascade impactors in terms of aerodynamic diameter.

As shown on the next viewgraph (LRA-25), this represents our current calculations of diameters from the Casella cascade impactor data. Now one of the problems again with this data, is that these three points are the only ones that are valid where this cascade impactor was actually sizing data. If we extrapolate this line 'way up here someplace to get to the 50 percent level, we are extrapolating well beyond the range where this cascade impactor was actually sizing. That's because, if we do this extrapolation, we calculate very large aerodynamic diameters, so this presents somewhat of a problem in terms of how do we use this data? These diameters, of course, are way too large to enter the lung dynamics model of the ICRP; so we have chosen to avoid that problem by taking this data apart. We treat it as though it were five individual samples, and then we use the data with an associated particle size for each one of these stages, plus the backup filter in the individual front end of this thing, so that we have broken it apart basically into five different samples.

The next viewgraph (LRA-26). We have significantly changed our inhalation calculations from the last time they were presented, in the sense that before we only made these calculations for the lung. As we prepared for this case (litigation), we felt that we must, in order for completeness, do these calculations for the other organs; so we have added all of these other organs. The semicolon represents a difference in sex. We calculate for ovaries and uterus for females and testes for males. So that we have done those calculations for those organs; and in order to make sure that we had the appropriate radionuclides for all of these additional organs, we did add several new radionuclides: Strontium to look at bone marrow dose, and mainly these, to make sure that we had the refractory elements that might be of some interest in terms of

the dose to the gastrointestinal tract.

Now the next viewgraph (LRA-27) is a list of all of the other radionuclides that we had previously considered for the lung only, and these are arranged in order of decreasing dose commitment. Plutonium-239 is essentially a trivial dose to the lung, and we've only done a few calculations for it for completeness. This gives us a total of 46 radionuclides that we have considered in these calculations, not counting plutonium.

The next viewgraph (LRA-28) indicates an ordered procedure that we followed for these calculations in terms of where we get the air concentration data. We have always used the cascade impactor data where it was available as our first choice, mainly because of the important input that gives us in terms of particle size and thus entry into the lung dynamics model. Now if we don't have a cascade impactor data, and you may recall that after TEAPOT there were no cascade impactor measurements generally made and reported in the literature, so from PLUMBBOB on all we have is the high volume sampler data. In that case what we have typically done is to assume that the activity median aerodynamic diameter was 10 micrometers, which is probably quite a conservative assumption, at least in terms of a lung dose; perhaps not in terms of doses to internal organs.

Now if we have neither of these kinds of data available, what we have done is to use data from the closest town that did have such data, and we've simply ratioed the activity measured there according to the mR/hr at the two different locations.

So the next viewgraph (LRA-29) indicates again what we've done. Where particle size data are available, this is no longer really proposed, this is what we did particularly for the litigants. If we ever found a diameter less than 20 micrometers, we would use the ICRP lung model directly in terms of entering it. This has never been the case where we have an aero-

dynamic diameter of less than 20 micrometers as measured by a cascade impactor. So what we have always done is to separate the data by stage and essentially calculate as though we had five separate measurements of air concentration with five different particle size distributions. These are the particle sizing parameters that are actually measured for this cascade impactor and reported by Lippman.

Okay, the next viewgraph (LRA-30) is just an indication of the status of our individual dose assessment model. It is not completely general at this time. That's for several reasons, the most notable of which is that we don't have all of the air quality data coded and calculated. This is partly a problem of digging that data out of the Los Alamos original notes and going through the rather laborious hand calculations coming up with those data; so that we are still in the process of doing that. In this picking of a reference location, if we don't have a measured air concentration, we are still doing that by hand at the present time, and probably will continue to do that by hand until we have worked our way through all of the locations for the significant shots.

The next viewgraph (LRA-31) indicates the results of these calculations. This is done for ——— as an example, for shot HARRY. It gives the results of the different organs across the top by radionuclide. Just as an example, looking at the thyroid dose for shot HARRY, this indicates 2.5 rads. The important radionuclides, as shown here, are iodine-135, iodine-133, tellurium-132, and iodine-131 as an indication of the somewhat difference in importance of radionuclides as evidenced by the more prominence of the short-lived radionuclides. The lower large intestinal wall is the next most significant dose by inhalation here, as indicated, and the most important radionuclide is the Neptunium-239, and there are several other radionuclides of less significant importance.

This is again the dose via inhalation only, and this compares to a calculation of about 40 rads via ingestion.

These results I have for all the litigants, if you're interested in them. They have not been handed out. The material gets to be very voluminous considering each individual radionuclide in each event for each individual.

The next viewgraph (LRA-32) is the summary of these doses, which has been handed out for each litigant. Again this is our numbers for shot HARRY for : the numbers that were on the previous viewgraph; and you see it summed up here now for the total events of 2.9 rads to the thyroid and 0.41 rads to the lower large intestine.

The next viewgraph (LRA-33). The next problem in terms of providing doses for the litigants was to add up all these doses that we've been talking about from the external pathway, the ingestion pathway, the inhalation pathway, and also to deal with the doses from in utero exposure. There were some problems in achieving that summation, because as it turned out, the groups had provided different kinds of data. The Los Alamos calculations provided us with geometric means and doses at the 1%, 10%, 90%, and 99% probability levels from which one can, of course, extract a geometric standard deviation.

We, on the other hand, have provided an arithmetic mean and have estimated a geometric standard deviation. We have, I should mention, assumed that the geometric standard deviation for the dose from inhalation was the same as it is for the dose from ingestion.

So how do we deal with these different kinds of distributions, and so forth? The next viewgraph (LRA-34) shows how we did this. We have summed the arithmetic means, and where we had a geometric mean we can calculate an arithmetic mean. We have assumed that the one thing you can do when you

are summing distributions reliably, is to sum the arithmetic means, and also, no matter what the distribution is, that you can sum the variances; that the variance of the sum is equal to the sum of the individual variances. Once we have done that, we then have an arithmetic mean and an arithmetic standard deviation. If we know that we can, indeed, calculate back to a geometric mean and a geometric standard deviation to provide a distribution of values.

The next viewgraph (LRA-35) shows the relationships between all of these parameters. We've already seen that one. This is how we calculate an arithmetic standard deviation where a variance is shown here, if we know the geometric standard deviation and also the geometric mean. And these two show how, if we know an arithmetic mean, or an arithmetic standard deviation, how we can calculate the geometric mean and the geometric standard deviation. These results, by the way, are taken from a paper by Dunning and Schwarz (published) in Health Physics.

Well, the next four viewgraphs (LRA-36, -37, -38, -39) show the results of doing all of these calculations. (LRA-36) _ was an individual who had melanoma. For his case we are looking now at the beta dose on the skin directly from the Los Alamos calculations. This indicates the probability distribution. The most likely dose is 310 rads. We are 90 percent confident that his dose was equal to or less than 590 rads, and so forth.

The next viewgraph (LRA-37), the doses for _ , he had Hodgkin's disease. We have assumed that the organ of interest is the whole body. This indicates now that -- in his case we have an in utero exposure, and this is not the one that Yook Ng calculated, but this is largely in utero exposure from external dose. This comes from Los Alamos. We see a fairly typical result that the dose from ingestion is much smaller, say,

for total body. The dose from inhalation is much smaller yet. Then we have this summing up.

The next viewgraph (LRA-38) is for _ - from St. George, I believe. Leukemia. Calculations to the bone marrow, again dominated by the external dose followed by ingestion and then inhalation.

Then finally the dose to ; (LRA-39). Thyroid cancer. Dose to the thyroid. In this case we have a dominance of the dose from ingestion; a much smaller dose from inhalation, but the inhalation in this case is about equal to the dose via the external pathway. And our summation then is a most likely dose of 31 rads; a probability of 99% that the dose is equal to or less than 252 rads. Those are four of the 26 that were calculated among the litigants. Those results have also been handed out to you.

Let me just conclude with the next viewgraph (LRA-40) which is something that's on quite a little bit different subject, but it is something that we did present to the court as one of the validation studies that we did in looking at the validity of the external dose calculations done by Los Alamos. Now the basic data here is something that I've showed you before in terms of an accumulative probability distribution. The lawyers didn't like that kind of accumulative lognormal plot, so we redid this in terms of a histogram of the measurements of external exposure at St. George, Utah, during PLUMBBOB. There were 33 individuals who essentially wore a badge during the PLUMBBOB series, and this is the distribution of the exposures on those film badges with a geometric mean of 150 R, and then an arithmetic mean of 190 R.

The Test Manager's Committee -- pardon me?

DR. McCLELLAN: mR.

DR. ANSPAUGH: mR. I'm sorry. The Test Manager's Committee number

was, as I recall, something like 700 mR as estimated here, and you can see that is quite a conservative estimate in general for St. George for PLUMBBOB. These are the calculations that were actually done for the litigants by Los Alamos. There were seven individuals who were in St. George and were the litigants. Now none of the litigants themselves had film badges as it turned out, but the calculations that Los Alamos did, did fit very nicely within this overall distribution of the actual measurements that were recorded by film badges at St. George. So that this was another example of the validation studies that we did do and did present to the court.

Any questions?

CHAIRMAN MOSELEY: Questions for Dr. Anspaugh?

DR. McCLELLAN: I have a couple. Going back into Yook Ng's, it wasn't clear to me why we identified a surrogate mother for the three individuals, and it seems to me you really took pains almost to not identify a typical surrogate mother, but you took an extreme.

DR. ANSPAUGH: Well, as I recall -- Yook may want to say that -- the surrogate was taken as a person who was, in fact, there at the same location at the same time. We did not have the data for the actual mother in order to make these calculations in a proper lifestyle manner; so that in the lack of that particular kind of data, the choice was made to look at the individual females who were at that location at that time, and to use essentially in this case the highest one. That mainly was because we didn't have any better data. In that particular case it didn't make a whole lot of difference because the in utero doses were quite small from the internal pathway. They were certainly dominated by the external pathway.

DR. McCLELLAN: Was an attempt made to reconstruct the dose to the

actual mother from the external?

DR. ANSPAUGH: Not to the actual mother. Am I wrong on that, Dick?

MR. HENDERSON: Richard Henderson from Los Alamos. As you pointed out, we had no information regarding the actual mother, and we picked -- since we are not as closely tied to location, we took a lifestyle that was described by one of the litigants as being typical of a mother at that time and used that kind of information, what her habits were as far as being inside and outside the house. We did use the house that was described by the litigant. We did not go back and say that was the litigant's mother, per se. We also have a surrogate.

DR. McCLELLAN: I was wondering in terms of on the cascade impactor data, roughly how many of those data sets do you have that you have worked through already, and how many are potentially available?

DR. ANSPAUGH: Well, I really can't give you a hard number, but on the Operations TUMBLER/SNAPPER, UPSHOT/KNOTHOLE, and TEAPOT, there are probably as many of those measurements as there are high volume samplers. I would estimate there is something like 10-12 locations that actually had these cascade impactors per event for those series.

DR. McCLELLAN: Were they deployed with a high vol at the same site in each case?

DR. ANSPAUGH: I think in almost all cases if there was a cascade impactor, there was a high volume sampler, and I have presented some comparisons between the two data. They track surprisingly well.

DR. McCLELLAN: What further have you done on that front in terms of --

DR. ANSPAUGH: How well they track?

DR. McCLELLAN: Yes, have you done any further --

DR. ANSPAUGH: I haven't done anything more than what I have

presented. I think I presented two direct comparisons. One was at Lincoln Mine for shot NANCY from the sheep. Then I also presented the data for shot HARRY at St. George. In those two cases they track amazingly well.

CHAIRMAN MOSELEY: Other questions of Dr. Anspaugh?

DR. CALDWELL: When you did the thyroid, you took into account the size of the thyroid in the child, right? Difference in size in a child from an adult?

DR. ANSPAUGH: We age corrected that in the general manner. Of course, we have no exact data for a particular individual. All of these calculations are done in an age adjusted manner for the ingestion and inhalation, which includes the size of the thyroid.

DR. CALDWELL: I thought that's what you did before, but I just couldn't remember.

CHAIRMAN MOSELEY: Thanks, sir.

CALCULATION OF DOSE FROM INGESTION

mR/hr at H+12	Measurement
$\times$	
$\frac{\mu Ci/m^2}{mR/hr \text{ at } H+12}$	Source-term calculation
$\times$	
$\frac{\mu Ci}{\mu Ci/m^2}$	Pathway model food → man
$\times$	
$\frac{rad}{\mu Ci}$	Human-metabolism model Age-specific adjustment

ESTIMATION OF UNCERTAINTY FOR DOSE VIA INGESTION

$$\frac{\text{mR}}{\text{h}} \times \frac{\mu\text{Ci/m}^2}{\text{mR/h}} \times \frac{\mu\text{Ci}}{\mu\text{Ci/m}^2} \times \frac{\text{rad}}{\mu\text{Ci}}$$

$$\sigma_g = 1.5 \qquad 1.0 \qquad 2.0 \qquad 1.8$$

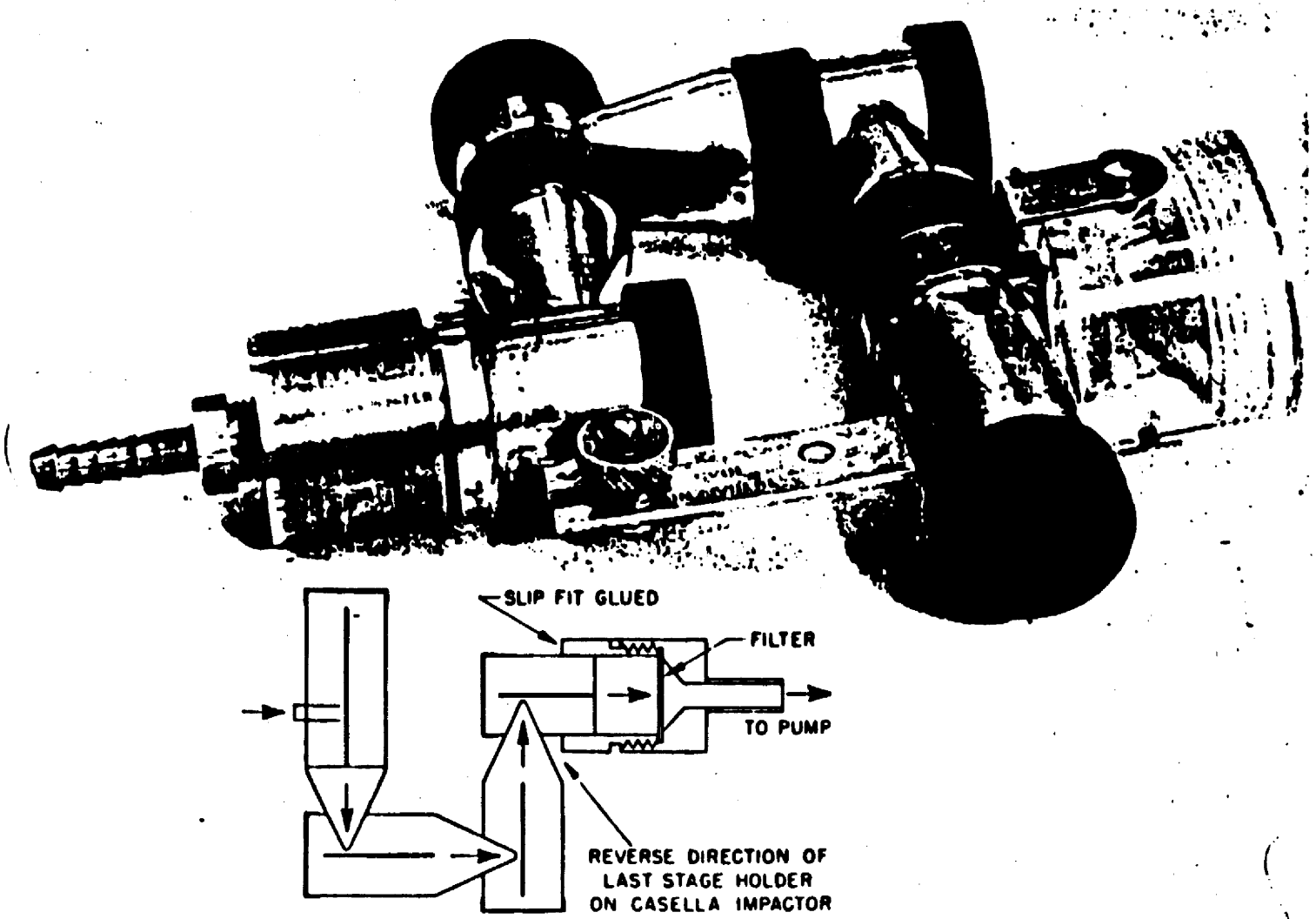
$$\exp\sqrt{\sum(\ln\sigma_g)^2} = 2.7$$

$$\bar{x} = \bar{x}_g \exp((\ln\sigma_g)^2/2) = \bar{x}_g \cdot 1.6$$

CALCULATION OF DOSE FROM INHALATION

$\frac{\mu Ci_T}{m^3}$	Measured air concentration
$\times$	
hr	Length of sampling time
$\times$	
$\frac{m^3}{hr}$	Breathing rate
$\times$	
$\frac{\mu Ci}{\mu Ci_T}$	Radionuclide-specific source term
$\times$	
$\frac{rad}{\mu Ci}$	Human-metabolism model Age-specific adjustment

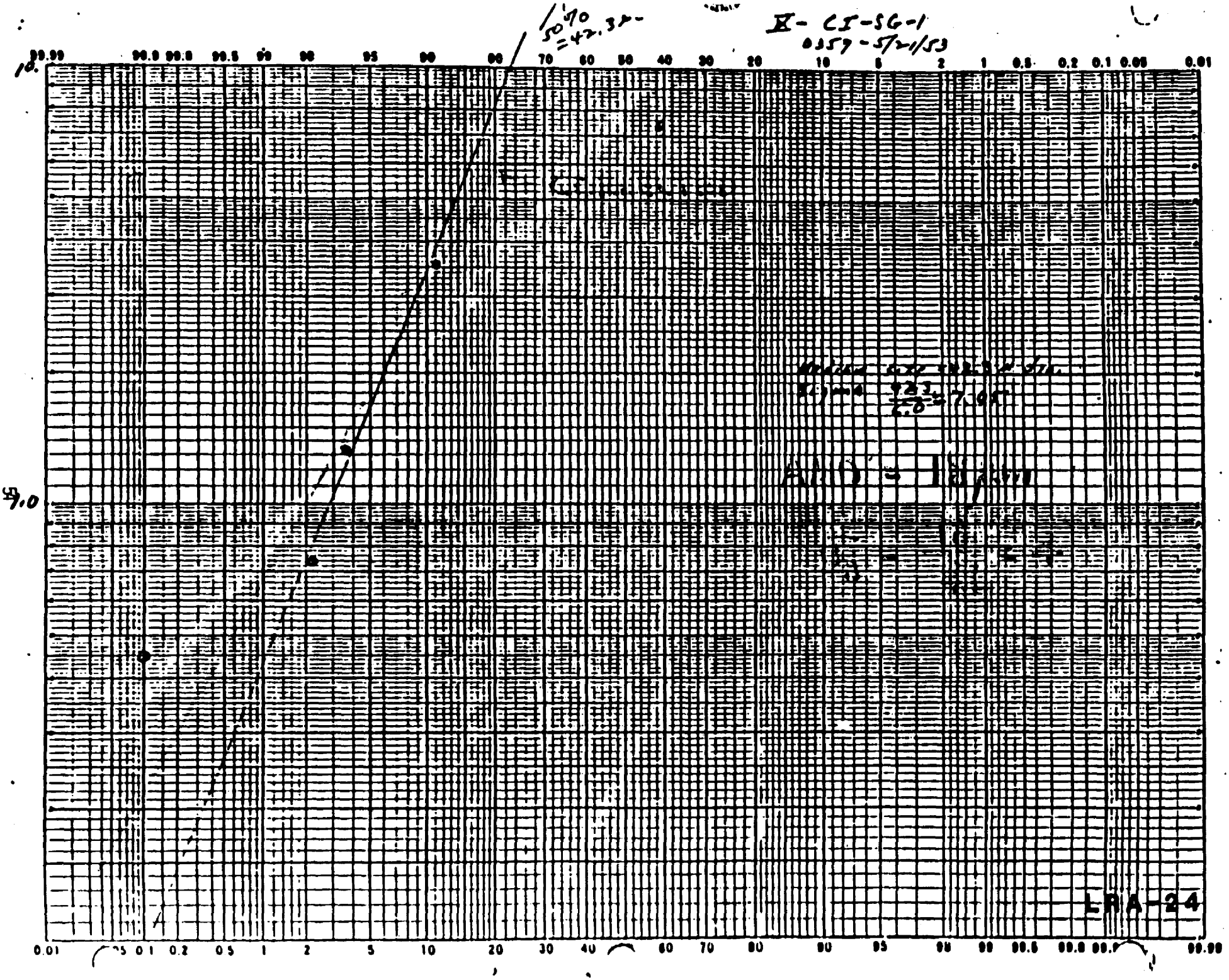
CASELLA CASCADE IMPACTOR

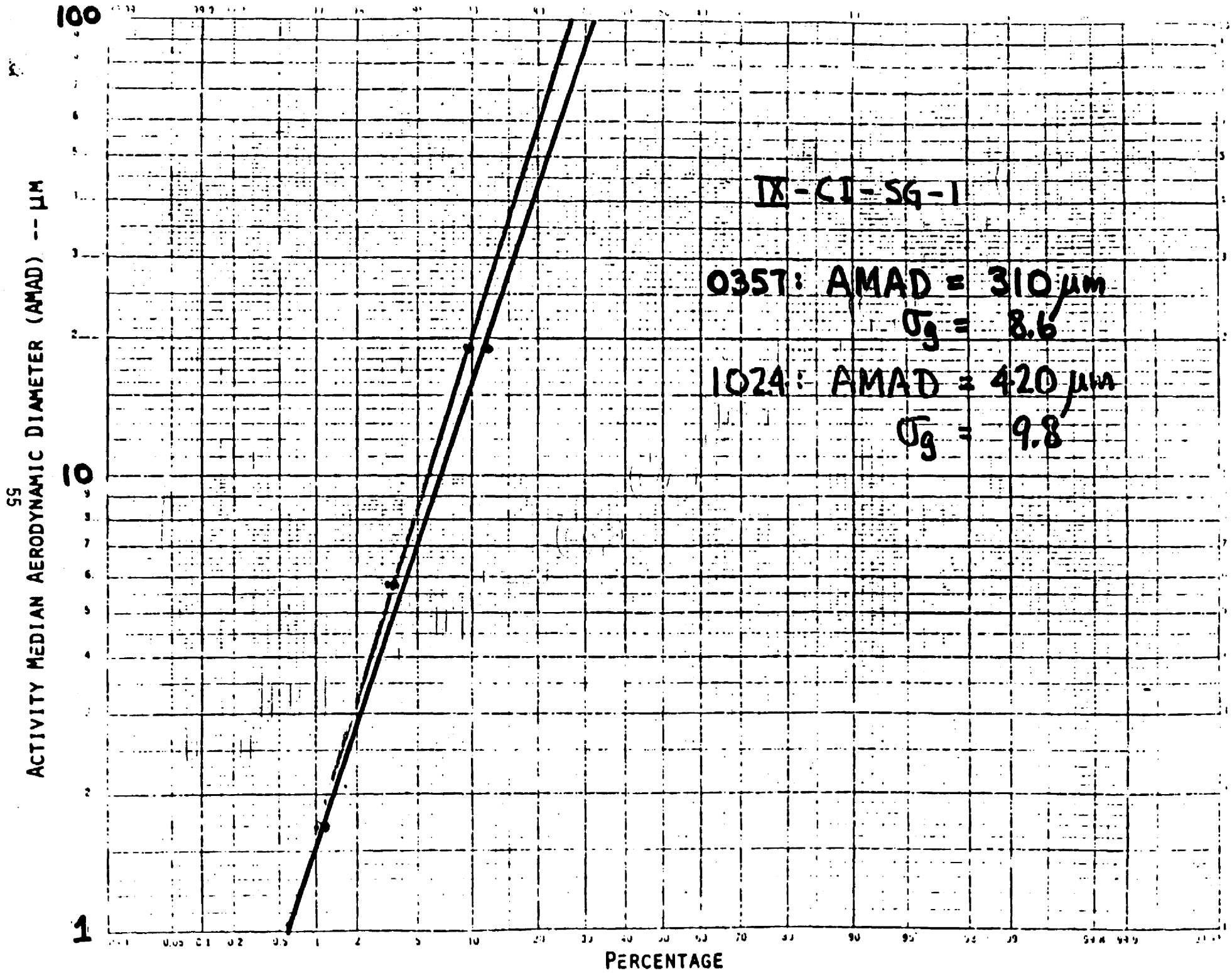


SOURCE: LASL, ENCY. INSTR. INDUST. HYG., U. MICHIGAN, ANN ARBOR (1956) P. 143

Sta.	Code	Volume of air Sampled (cu.m.)	Stage	Counts: 1st net count	Counts	Calculations: % of total	Calculations: cumulative %	Accum. Median	Particle Size: Mass Median	Particle Size: Std. Sigma	Activity: Total uc	Activity: c/m3	
IX-C1-56-1	Collected 0610-1130 5/19/53		5	[illegible]		0.1	0.1	0.45					
			4	37,900		2.0	2.1	0.76					
	Counted 0357 5/21/53		3	36,400		2.2	3.4	1.49					
			2	100,500		13.4	11.4	3.50					
			1	1,118,500		84.0	59.0	8.20			not applicable		
	5.6 M3		T	1,365,032	2,739,064	100.0	100.0		42.3	7.05	1.29	4.5	Factor 20.5
IX-C1-56-1			5	Norm. cpm 200	1,240	0.1	0.1	0.45					
	Counted 1024 5/21/53		4	3,700	45,100	1.9	1.0	0.76					
			3	7,100	95,100	7.1	3.4	1.49					
			2	23,000	131,200	10.9	9.6	3.50					
			1	172,000	1,082,000	85.0	57.5	8.20			not applicable		
	5.6 M3		T	203,000	1,170,560	100.0	100.0		25.1	4.65	1.17	5.0	Factor 24.0
			5					0.45					
			4					0.76					
			3					1.49					
			2					3.50					
			1					8.20					

LRA-23


LRA-24


IX-C1-SG-1
0357: AMAD = 310 µm
σg = 8.6
1024: AMAD = 420 µm
σg = 9.8
ACTIVITY MEDIAN AERODYNAMIC DIAMETER (AMAD) -- µM
SG
100
10
1
PERCENTAGE

CHANGES IN INHALATION CALCULATIONS

- Added organs:

  Bladder wall, bone surface, breast, stomach wall, lower large intestinal wall, kidneys, liver, pancreas, red marrow, testes, thyroid, brain; ovaries, uterus

- Added radionuclides:

  ^{89}Sr, ^{90}Sr, ^{103}Ru, ^{141}Ce, ^{144}Ce, ^{147}Nd

RADIONUCLIDES CONSIDERED, IN ORDER OF DECREASING DOSE COMMITMENT

Np-239	Sr-92	Ba-140	U-240	Te-133m
Sr-91	La-141	Y-91	Pm-149	Pm-151
I-133	Ce-143	Sb-129	I-131	La-140
Te-132	Ru-106	La-142	Cu-64	Y-91m
Zr-97	Mo-99	Zr-95	Nb-97	Pd-109
Y-93	Ba-139	I-132	Sb-128m	U-237
I-135	I-134	Te-131m	Te-134	Te-131
Y-92	Ru-105	Rh-105	Te-129	Sn-125
				Pu-239

ORDERED PROCEDURE FOR THESE CALCULATIONS

- Use cascade-impactor data
- Use high-volume sampler data
  Assume AMAD = 10 micrometers
- Use data from neighboring town and ratio according to mR/h at H + 12

PROPOSED TREATMENT FOR INHALATION WHERE PARTICLE SIZE DISTRIBUTION DATA ARE AVAILABLE

- If AMAD <20μm, use ICRP lung model

- If AMAD >20μm, separate data by stages, and then use the ICRP lung model

Filter	-	Assume 1μm
Stage 4	-	1.7μm
3	-	5.8μm
2	-	19 μm
1	-	Assume total deposition in N-P

INHALATION METHODS ARE NOT COMPLETELY GENERAL

- Not all air quality data are coded nor calculated
- Still pick reference locations by hand by location for each event

PRIVACY ACT MATERIAL REMOVED

NAME IS

Dose via Inhalation

SHOT NAME IS HARRY
LOCATION IS ST. GEORGE
FOUND 20 AIR CONCENTRATIONS
DOSES ARE IN RADS.

NUCLIDE	BLA WAL	BON SUR	BREAST	ST WALL	LLI WAL	KIDNEYS	LIVER	LUNGS	OVARIES	PANCREA	R MARRO	THYROID	UTERUS	BRAIN
CU 64	2.6E-05	1.8E-05	2.0E-05	1.8E-04	9.9E-04	2.4E-05	4.6E-05	5.9E-05	5.8E-05	5.3E-05	2.4E-05	1.4E-05	3.5E-05	4.6E-05
U237	0.	0.	0.	0.	8.0E-04	0.	0.	1.8E-05	0.	0.	0.	0.	0.	0.
U240	0.	0.	0.	0.	4.2E-03	0.	0.	7.7E-05	0.	0.	0.	0.	0.	0.
NP239	5.8E-04	2.6E-02	2.7E-04	3.7E-03	1.1E-01	2.9E-04	8.1E-03	1.7E-03	2.4E-03	3.9E-04	3.1E-03	2.8E-05	8.8E-04	0.
SR 89	8.4E-05	1.7E-03	8.6E-05	1.2E-04	1.7E-03	8.8E-05	8.8E-05	9.8E-05	8.5E-05	8.8E-05	1.3E-03	8.8E-05	8.8E-05	0.
SR 90	2.9E-06	8.0E-04	3.0E-06	2.7E-06	1.1E-05	3.0E-06	3.0E-06	3.0E-06	3.0E-06	3.0E-06	4.3E-04	3.0E-06	3.0E-06	0.
SR 91	1.1E-03	2.1E-03	9.2E-04	5.1E-03	2.5E-02	1.0E-03	9.9E-04	1.3E-03	1.9E-03	1.1E-03	2.8E-03	7.7E-04	1.4E-03	0.
Y 91M	1.6E-06	3.7E-06	1.5E-06	3.0E-05	1.6E-04	2.9E-06	5.0E-06	2.4E-05	4.6E-06	7.6E-06	4.6E-06	4.8E-07	3.8E-08	0.
Y 91	6.2E-07	3.0E-05	6.3E-07	3.1E-05	1.7E-03	6.3E-07	3.0E-05	2.3E-04	7.7E-07	6.3E-07	3.0E-05	6.0E-07	6.8E-07	0.
SR 92	4.6E-04	4.4E-04	4.1E-04	2.6E-03	1.1E-02	4.8E-04	4.6E-04	7.3E-04	6.7E-04	5.7E-04	6.7E-04	3.5E-04	6.0E-04	0.
Y 92	2.0E-05	2.4E-05	1.6E-05	3.7E-03	6.7E-03	2.5E-05	3.3E-05	7.1E-04	6.4E-05	3.6E-05	3.4E-05	5.6E-06	4.4E-06	0.
Y 93	3.1E-05	5.3E-05	1.8E-05	4.6E-03	4.0E-02	2.8E-05	6.1E-05	9.6E-04	9.7E-05	2.9E-05	6.6E-05	5.8E-06	5.2E-05	0.
ZR 95	4.2E-05	2.2E-03	5.2E-05	4.9E-05	7.8E-04	5.0E-05	3.9E-05	1.3E-04	1.1E-04	4.7E-05	2.8E-04	3.3E-05	5.9E-06	0.
ZR 97	7.2E-04	9.9E-04	4.3E-04	4.7E-03	6.1E-02	8.5E-04	4.4E-04	1.0E-03	2.2E-03	8.8E-04	4.4E-03	1.6E-04	1.1E-03	0.
NB 97	0.	0.	0.	0.	0.	0.	0.	5.6E-05	0.	0.	0.	0.	0.	0.
MO 99	1.4E-04	1.3E-04	6.2E-05	8.0E-04	2.4E-02	3.1E-04	3.6E-04	3.8E-04	3.9E-04	8.4E-05	1.9E-04	2.3E-05	1.9E-04	0.
RU103	4.5E-05	1.9E-05	2.0E-05	5.9E-05	3.0E-05	0.	2.8E-05	1.3E-04	1.1E-04	3.2E-05	2.6E-05	1.8E-05	5.6E-05	0.
RU105	0.	0.	0.	0.	6.9E-03	0.	0.	2.4E-04	0.	0.	0.	0.	0.	0.
RH105	0.	0.	0.	0.	8.2E-03	0.	0.	7.6E-05	0.	0.	0.	0.	0.	0.
RU106	1.7E-05	1.7E-05	1.7E-05	2.9E-05	6.9E-04	1.7E-05	1.7E-05	4.4E-04	1.9E-05	1.8E-05	1.7E-05	1.8E-05	1.8E-05	0.
PD109	3.2E-07	8.4E-07	2.7E-07	1.1E-04	1.3E-03	8.7E-06	4.6E-06	2.5E-05	2.1E-06	3.3E-07	7.9E-07	1.3E-07	5.4E-07	1.3E-07
SN125	0.	0.	0.	0.	4.3E-04	0.	0.	1.2E-05	0.	0.	0.	0.	0.	0.
SB128M	1.6E-07	1.6E-07	1.8E-07	2.1E-06	2.2E-07	2.2E-07	2.4E-07	1.2E-06	1.8E-07	4.8E-07	1.8E-07	1.5E-07	2.0E-07	1.0E-07
SB129	7.2E-05	5.1E-05	5.2E-05	6.8E-04	1.4E-03	8.0E-05	8.6E-05	9.9E-05	2.2E-04	1.1E-04	7.8E-05	2.0E-05	1.4E-04	1.6E-05
TE129	3.2E-06	4.1E-06	3.4E-06	1.6E-04	2.2E-05	3.5E-06	3.4E-06	3.5E-05	3.8E-06	4.0E-06	3.9E-06	3.2E-06	3.7E-06	0.
TE131M	1.1E-04	2.2E-04	7.0E-05	2.6E-04	9.0E-04	7.8E-05	6.4E-05	1.0E-04	3.1E-04	8.2E-05	1.3E-04	3.0E-02	1.6E-04	3.2E-05
TE131	3.0E-06	3.9E-06	3.8E-06	9.3E-05	3.0E-05	3.6E-06	3.3E-06	1.7E-05	4.9E-06	4.9E-06	4.4E-06	5.2E-03	4.4E-06	3.4E-06
I131	3.2E-05	7.4E-05	1.0E-04	1.2E-04	3.4E-06	9.7E-05	4.1E-05	1.1E-04	3.0E-05	4.4E-05	7.9E-05	4.6E-01	3.5E-05	0.
TE132	1.3E-03	2.9E-03	1.2E-03	1.3E-03	8.5E-03	1.2E-03	1.2E-03	1.2E-03	1.6E-03	1.2E-03	1.5E-03	2.2E-01	1.5E-03	9.7E-04
I132	6.3E-05	5.9E-05	6.4E-05	7.0E-04	7.9E-05	7.4E-05	7.1E-05	1.1E-04	8.1E-05	1.3E-04	8.6E-05	1.1E-02	7.2E-05	0.
TE133M	0.	0.	0.	0.	0.	0.	0.	3.6E-05	0.	0.	0.	8.9E-03	0.	0.
I133	4.5E-04	5.2E-04	5.9E-04	3.1E-03	5.3E-04	4.9E-04	5.1E-04	1.1E-03	4.5E-04	5.9E-04	5.5E-04	1.3E+00	4.7E-04	0.
TE134	0.	0.	0.	0.	0.	0.	0.	2.0E-03	0.	0.	0.	2.0E-03	0.	0.
I134	1.8E-04	1.7E-04	1.8E-04	3.5E-03	2.3E-04	2.3E-04	2.1E-04	2.8E-04	1.8E-04	5.0E-04	1.8E-04	1.2E-02	2.1E-04	0.
I135	7.0E-04	6.9E-04	7.7E-04	4.9E-03	8.5E-04	7.7E-04	7.5E-04	9.3E-04	1.1E-03	0.	7.4E-04	4.1E-01	7.8E-04	0.
BA139	0.	0.	0.	5.0E-03	0.	0.	0.	3.6E-04	0.	0.	0.	0.	0.	0.
BA140	0.	2.0E-03	2.4E-04	0.	1.0E-02	0.	0.	2.7E-04	0.	0.	1.3E-03	0.	0.	0.
LA140	0.	0.	0.	0.	1.2E-03	0.	0.	3.1E-05	9.1E-05	0.	0.	0.	0.	0.
LA141	5.1E-05	1.1E-04	5.2E-05	3.5E-03	6.5E-03	5.4E-05	7.0E-04	8.0E-04	6.3E-05	5.9E-05	1.1E-04	4.8E-05	5.8E-05	4.9E-05
CE141	4.9E-06	6.6E-05	2.6E-06	2.8E-05	1.3E-03	3.1E-06	5.9E-05	1.1E-04	1.6E-05	3.8E-06	1.1E-05	6.4E-07	7.0E-06	0.
LA142	4.4E-05	3.7E-05	4.1E-05	9.1E-04	2.6E-04	6.0E-05	1.3E-04	1.4E-04	1.0E-04	1.0E-04	5.0E-05	2.3E-05	8.3E-05	1.9E-05
CE143	1.4E-04	7.1E-05	6.3E-05	1.2E-03	2.9E-02	7.6E-05	2.5E-04	5.5E-04	5.4E-04	8.1E-05	1.5E-04	4.8E-06	2.2E-04	0.
CE144	3.0E-06	7.0E-05	3.1E-06	2.3E-05	1.0E-03	3.5E-06	3.5E-04	5.4E-04	3.9E-06	3.7E-06	4.6E-05	2.9E-06	3.3E-06	0.
ND147	8.2E-09	1.8E-08	3.7E-09	5.2E-08	2.2E-06	1.2E-08	4.2E-08	7.3E-08	3.0E-08	4.1E-09	1.3E-08	2.4E-10	1.2E-08	1.2E-10
PM149	3.0E-08	1.7E-07	1.2E-08	3.8E-06	1.5E-04	1.5E-08	5.4E-07	1.9E-06	1.1E-07	1.5E-08	1.8E-07	4.9E-10	4.5E-08	2.5E-10
PM151	1.2E-07	6.7E-08	5.2E-08	7.5E-07	1.6E-05	6.6E-08	9.7E-08	2.0E-07	4.4E-07	7.2E-08	1.2E-07	1.9E-09	1.9E-07	8.6E-10
TOTAL	6.4E-03	4.2E-02	5.7E-03	5.1E-02	3.6E-01	6.1E-03	1.8E-02	1.8E-02	1.3E-02	6.0E-03	1.8E-02	8.5E+00	8.3E-03	1.1E-03

1
NAME IS

Dose via Inhalation

FOUND 1 LOCATIONS, 6 SHOTS, AND 48 AIR CONCENTRATIONS.
DOSES ARE IN RADS

ORGAN	UNCLE	TS-EASY	TS-FOX	ANNIE	SIMON	HARRY	TESLA	TURK	HORNET	APPLE I
BLAD WAL	0.	0.	0.	2.3E-05	1.0E-04	6.4E-03	3.4E-04	0.	0.	0.
BON SURF	0.	0.	0.	1.7E-04	7.8E-04	4.2E-02	3.0E-03	0.	0.	0.
BREAST	0.	0.	0.	2.3E-05	9.9E-05	5.7E-03	3.1E-04	0.	0.	0.
ST WALL	0.	0.	0.	1.9E-04	6.8E-04	5.1E-02	1.7E-03	0.	0.	0.
LLI WALL	0.	0.	0.	1.3E-03	6.6E-03	3.6E-01	2.0E-02	0.	0.	0.
KIDNEYS	0.	0.	0.	2.4E-05	1.0E-04	6.1E-03	3.2E-04	0.	0.	0.
LIVER	0.	0.	0.	6.0E-05	2.5E-04	1.5E-02	9.8E-04	0.	0.	0.
LUNGS	0.	0.	0.	2.7E-04	2.6E-04	1.8E-02	2.9E-03	0.	0.	0.
OVARIES	0.	0.	0.	4.8E-05	2.3E-04	1.3E-02	6.8E-04	0.	0.	0.
PANCREAS	0.	0.	0.	2.4E-05	9.8E-05	6.0E-03	3.1E-04	0.	0.	0.
R MARROW	0.	0.	0.	7.7E-05	3.7E-04	1.8E-02	1.1E-03	0.	0.	0.
THYROID	0.	0.	0.	1.3E-02	6.6E-02	2.5E+00	1.7E-01	0.	0.	0.
UTERUS	0.	0.	0.	3.1E-05	1.4E-04	8.3E-03	4.2E-04	0.	0.	0.
BRAIN	0.	0.	0.	4.6E-06	2.4E-05	1.1E-03	8.9E-05	0.	0.	0.

ORGAN	MET	ZUCCHINI	WILSON	PRISCILLA	DIABLO	SMOKY	NEWTON	MORGAN	SMALL BOY	PIKE
BLAD WAL	0.	3.9E-05	0.	0.	0.	3.0E-04	0.	0.	0.	0.
BON SURF	0.	2.2E-04	0.	0.	0.	2.0E-03	0.	0.	0.	0.
BREAST	0.	3.8E-05	0.	0.	0.	2.9E-04	0.	0.	0.	0.
ST WALL	0.	2.1E-04	0.	0.	0.	1.6E-03	0.	0.	0.	0.
LLI WALL	0.	1.9E-03	0.	0.	0.	1.6E-02	0.	0.	0.	0.
KIDNEYS	0.	3.8E-05	0.	0.	0.	2.9E-04	0.	0.	0.	0.
LIVER	0.	6.7E-05	0.	0.	0.	6.2E-04	0.	0.	0.	0.
LUNGS	0.	3.0E-04	0.	0.	0.	2.3E-03	0.	0.	0.	0.
OVARIES	0.	7.3E-05	0.	0.	0.	5.8E-04	0.	0.	0.	0.
PANCREAS	0.	3.6E-05	0.	0.	0.	2.8E-04	0.	0.	0.	0.
R MARROW	0.	1.3E-04	0.	0.	0.	1.0E-03	0.	0.	0.	0.
THYROID	0.	1.8E-02	0.	0.	0.	1.4E-01	0.	0.	0.	0.
UTERUS	0.	4.9E-05	0.	0.	0.	3.8E-04	0.	0.	0.	0.
BRAIN	0.	9.7E-06	0.	0.	0.	7.4E-05	0.	0.	0.	0.

ORGAN	PIN STRIPE	TOTAL
BLAD WAL	0.	7.2E-03
BON SURF	0.	4.8E-02
BREAST	0.	6.5E-03
ST WALL	0.	5.6E-02
LLI WALL	0.	4.1E-01
KIDNEYS	0.	8.9E-03
LIVER	0.	1.7E-02
LUNGS	0.	2.4E-02
OVARIES	0.	1.5E-02
PANCREAS	0.	6.7E-03
R MARROW	0.	2.1E-02
THYROID	0.	2.9E+00
UTERUS	0.	9.4E-03
BRAIN	0.	1.3E-03

PROBLEMS IN ACHIEVING SUMMATION

- Want probability distribution

- Input data were different

  LANL: Geometric mean, $\bar{x}_g$, and doses at the 1%, 10%, 90%, and 99% levels

  LLNL: Arithmetic mean, $\bar{x}$, and estimated geometric standard deviation, σ_g

SUMMATION

- Sum arithmetic means:

$$\bar{x}_T = \sum \bar{x}$$

- Sum variances:

$$\sigma_T^2 = \sum \sigma^2$$

- Calculate geometric mean and standard deviation from the arithmetic mean and standard deviation

RELATIONSHIPS OF PARAMETERS

$$\bar{x} = \bar{x}_g \exp\left[(\ln \sigma_g)^2/2\right]$$

$$\sigma^2 = \exp\left[2 \ln \bar{x}_g + (\ln \sigma_g)^2\right] \times \left[\exp((\ln \sigma)^2) - 1\right]$$

$$A = 1 + (\sigma/\bar{x})^2$$

$$\bar{x}_g = \frac{\bar{x}}{\sqrt{A}}$$

$$(\ln \sigma_g)^2 = \ln A$$

PRIVACY ACT MATERIAL REMOVED

Name: -----

Organ of interest: Skin

Calculated dose (rad)

Pathway	Geometric mean	Geometric standard deviation	Arithmetic mean	Arithmetic standard deviation
External:	310.	1.7	350.	190.
Ingestion:		Negligible		
Inhalation:		Negligible		

Total dose:	Probability:	1%	10%	50%	90%	99%
	Dose (rad):	95.	160.	310.	590.	1000.

PRIVACY ACT MATERIAL REMOVED

Name:

Organ of Interest: Whole body

Calculated dose (rad)

Pathway	Geometric mean	Geometric standard deviation	Arithmetic mean	Arithmetic standard deviation
IN UTERO	0.26	1.4	0.27	0.090
External:	0.24	1.3	0.25	0.059
Ingestion:	0.0049	2.7	0.0080	0.010
Inhalation:	0.00022	2.7	0.00036	0.00047

Total dose:	Probability:	1%	10%	50%	90%	99%
	Dose (rad):	0.32	0.40	0.52	0.67	0.83

PRIVACY ACT MATERIAL REMOVED

Name:

Organ of interest: Bone marrow

Calculated dose (rad)

Pathway	Geometric mean	Geometric standard deviation	Arithmetic mean	Arithmetic standard deviation
External:	2.6	1.3	2.7	0.67
Ingestion:	0.070	2.7	0.12	0.15
Inhalation:	0.012	2.7	0.019	0.025

Total dose:	Probability:	1%	10%	50%	90%	99%
	Dose (rad):	1.6	2.0	2.8	3.7	4.8

PRIVACY ACT MATERIAL REMOVED

Name:

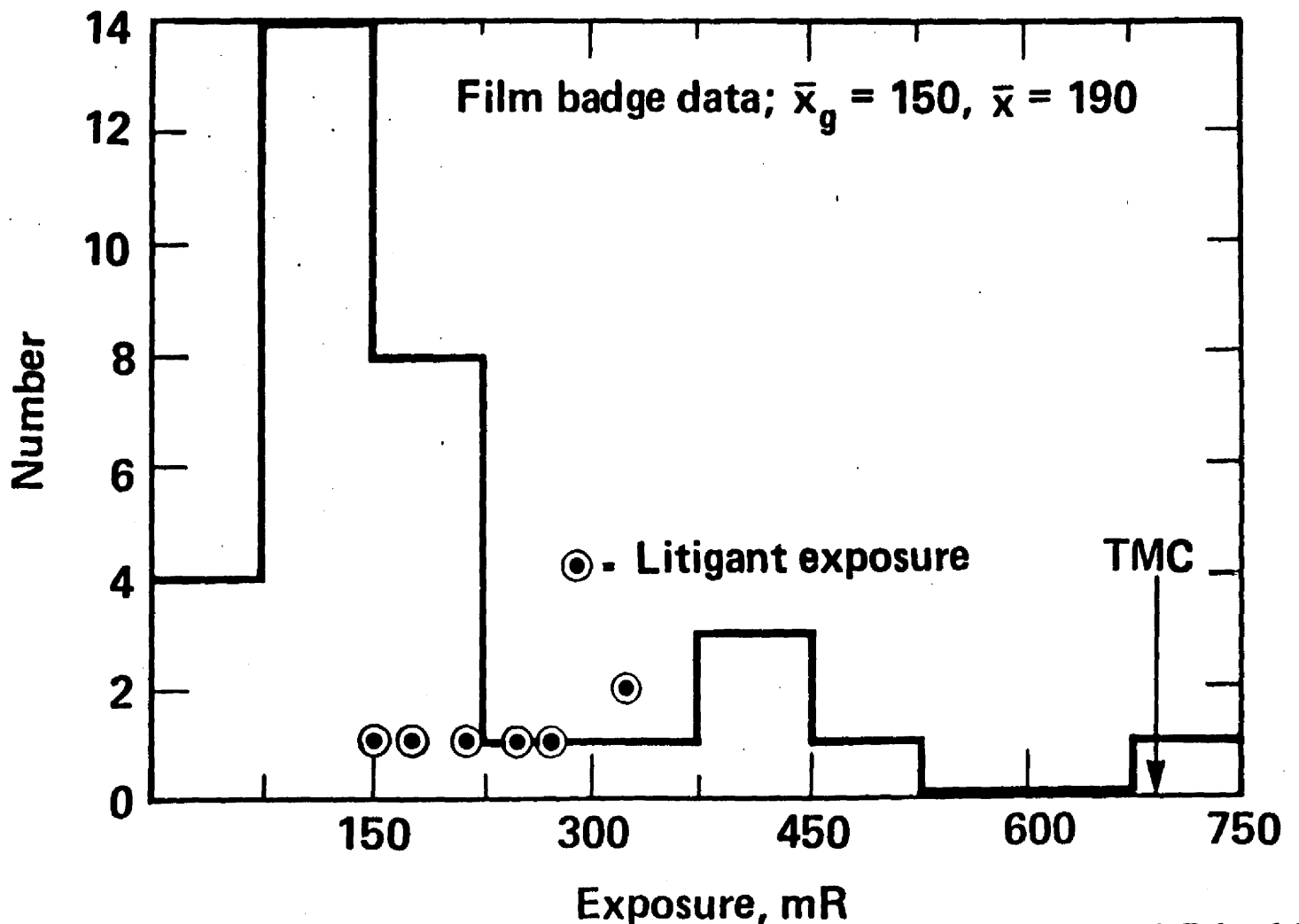
Organ of interest: Thyroid

Calculated dose (rad)

Pathway	Geometric mean	Geometric standard deviation	Arithmetic mean	Arithmetic standard deviation
External:	3.0	1.4	3.2	1.0
Ingestion:	24.	2.7	40.	52.
Inhalation:	1.8	2.7	2.9	3.8

Total dose:	Probability:	1%	10%	50%	90%	99%
	Dose (rad):	3.7	9.6	31.	98.	252.

OMPARISON OF MEASUREMENTS AND CALCULATIONS
T. GEORGE – PLUMBBOB



LRA-40

CHAIRMAN MOSELEY: We're going to change subjects now. The rest of the morning is essentially going to be spent on discussion of various aspects of soil sampling. We will start with Forest Miller.

DR. MCCLELLAN: Excuse me, Bob. Later today in the wrap-up, am I correct to assume that Bruce Church is going to give us a little bit of a feeling where this is going from here in, e.g., the internal dose area?

CHAIRMAN MOSELEY: That's what is being scheduled.

MR. CHURCH: I'm going to talk somewhat about that.

DR. MCCLELLAN: I'm interested in having some time to discuss that.

DR. MILLER: This turned out to be one of the more fun things of the project so far; sort of paid vacations. We visited eastern California, Nevada, northern Utah, southeastern Oregon, southern Idaho, southwestern Wyoming, western Colorado, northwestern New Mexico, and northern Arizona, looking for candidate soil sampling sites. We found 306 of them at 132 locations. Many locations had multiple candidate sites. The towns with triangles beside them, like Montrose, Rifle and Meeker, had soil samples taken (FM-2). I think there were about 190 soil samples taken from about 117 locations. Livermore rejected some of our soil sampling site candidates and substituted others so that the 306 isn't really fixed.

We tried to select soil sampling sites which met the EML criteria which you got in Standing Order 4. In brief, the areas EML were interested in were undisturbed, and yet maintained since 1950, at least 40 feet in diameter, relatively flat and open and with ground cover such as grass to minimize wind or water erosion. We also watched for low places in lawns that would serve as collection points due to rain bringing in fallout.

We ranked these candidate sites as either "A," "B," or "C." "A" meaning, meets the EML criterion every way we knew; "B" meaning slight deviation from optimality which might mean some trees in the lawn, or the

lawn was slightly small, and "C," sort of best available in the areas but not "A" or "B." As you can recognize, (laughter) there are some places where we didn't have lawns, and we just had to sort of pick the best thing we could find. Now if I can just master this technology, I would like to show you a few pictures.

This (Site No. BE-23) is a lawn in Bishop, California. All three teams rated it an "A." It's about 50x50 with the estimated age from the owner of 60 years. This (Site No. KS-37) is a field behind the Hiko Post Office in Hiko, Nevada. You're just seeing a part of it. The field was about 1,000' x 1,000' and, according to the postmistress, it had been undisturbed for 40 years -- The order has been changed.-- That (Site No. AS-26) is the Rio Blanco Courthouse in Meeker, Colorado. Also a Triple A. The Courthouse was built in 1935 and several people verified that the lawn was over 30 years old. The Old House in Mancos, Colorado (Site No. AS-08), I believe, yes, 100 x 100 foot lawn. The house was built in 1889. We rated it a "B" because we thought the weeds and lack of care indicated that it might not be an optimal site. The other two people, the other two groups, rated it an "A." That's (Site No. AS-06) a park, Montezuma Park, Cortez, Colorado. The soil sampling site itself was out there where the sprinklers are, an area roughly 200 x 300 with trees around the edges. People verified that that had been undisturbed since 1949. This (Site No. AS-01) is a fairgrounds in New Mexico, Farmington, New Mexico, another Triple A site. I don't know what house this (Site No. FM-51) is, unfortunately.

CHAIRMAN MOSELEY: Law offices.

DR. MILLER: Oh! Okay, that's Arizona. That is Flagstaff. It's law offices in downtown Flagstaff; a level side yard. People were concerned that there might have been some fill put in here. We were only able to be

guaranteed that nothing had happened the past 15 years. Before that, it had been a fraternity house.

(Laughter)

Nobody thought that they would have been digging holes in it, and we located one of the brothers, and he said, "No, nothing has ever happened," that he remembered. We called it an "A." Livermore called it a "B" because they thought that there could have been some fill. This picture was taken while standing on a wall at the far end of the lawn and toward the wall was downhill, and people thought it could have been filled recently.

This (Site No. FM-54) is the Bureau of Indian Affairs Park in Fort Defiance, Arizona, a large grassy area surrounded by trees; and according to both the Bureau of Indian Affairs in Fort Defiance and the people who run the hospital, which is just down the road, it was undisturbed for at least 35 years. In the trees in the back (Site No. FM-39) is the house of the owner of Garcia's Trading Post in Chinle, Arizona, and the lawn is undisturbed since it was planted in 1926. Unfortunately, my slide of the lawn turned out to be crummy, and this is sort of a substitute. I apologize for it, but it was heavily covered by trees and so that was a potential detriment.

This (Site No. FM-12) is an open woodland near Tusayan Ruins in the Grand Canyon National Park; somewhat sparse cover. We rated it a "B" for that purpose. The REECo soil collection team rated it a "C" because they couldn't get below six inches. The large tree you see sort of in the right center, because of the low site index, is probably 125-150 years old. This (Site No. FM-10) is a meadow just off of Grandview Tower Road in the Grand Canyon National Park. Both of these places are on the South Rim, and this a Triple A site. We were able to get deep enough to get a good soil sample

as well as good cover. I will confess that I don't know what this is. I'll just sort of pass on it. (Site No. AS-32. Bunnings Park, Rock Springs, Wyoming.)

An outhouse. (Site No. AS-49. Memorial Park, Pocatello, Idaho.)

If I have no complaints from the Projection Room then I have done the technology right, and they can now take the slides off the projector. Any questions?

MR. ZIMMERMAN: I have a question. On your map of sites from which you have taken soil, I notice that you didn't take any samples in the areas that were the probable source of milk supply for the Salt Lake City area and the Wasatch front areas. I wonder why that was. Had that been sampled previously by the EML?

DR. MILLER: We were only in Utah in the northwestern part, the parts that had not been covered previously by EML.

MR. ZIMMERMAN: So this other has adequately been done by the prior work group?

DR. MILLER: No. I would let Harold comment on that.

MR. BECK: Bruce.

MR. CHURCH: I think we're going to do some more soil sampling in Utah.

(LRA-52) The colors help highlight a little better where we've been. Dr. Anspaugh will be addressing what the red dots and so forth mean later, but you can see that there is a big hole in the State of Utah, and the reason is that EML had previously sampled throughout the state, and as we discussed last May, the purpose of this sampling is an extension of that work and hoping to look in a contemporary time frame throughout the region, and what we tried to do in that western corner of Utah is to fill in some of the area that EML did not sample, and we were particularly interested

because of the fallout tracks, if you remember back to some of the patterns that we had previously shown. Now, I will be speaking a little bit later in terms of future plans on some work we plan to do within the state according to the recommendations you gave us last May.

CHAIRMAN MOSELEY: There are some reconfirmatory spots that you were going to look at.

MR. CHURCH: Yes. I'll go into a little more detail then, later on.

DR. MALIK: Was there any attempt to sample in the same places that Kermit Larson's group sampled?

MR. CHURCH: No.

DR. MALIK: I would sort of like to have a direct comparison in a few places.

MR. CHURCH: Early in the project we had Van Romney go back to a number of those stations that they called "Persistent Stations" and had him take a sort of a last sweep of samples through those stations and he -- do you remember the status of that report? It's not a published report, but I guess I failed to recognize it yesterday. Those stations did reach into Utah. I think near Enterprise was the -- or, St. George, Veyo, Enterprise, Montamesa and a couple of other test stations.

DR. ANSPAUGH: They were typically not the same kind -- they wouldn't meet the same criteria in terms of lawns and the same thing that we are looking for here, though. They were basically desert areas.

MR. CHURCH: That's true, and I was going to add those same kinds of words. They sampled, I believe they sampled soil, natural vegetation in those particular areas and what wildlife was available; such as in the Enterprise area, you could get jack rabbits and stuff like that, but I don't think they are directly comparable to the EML type of effort.

DR. MALIK: I was wondering about migration of clides from high

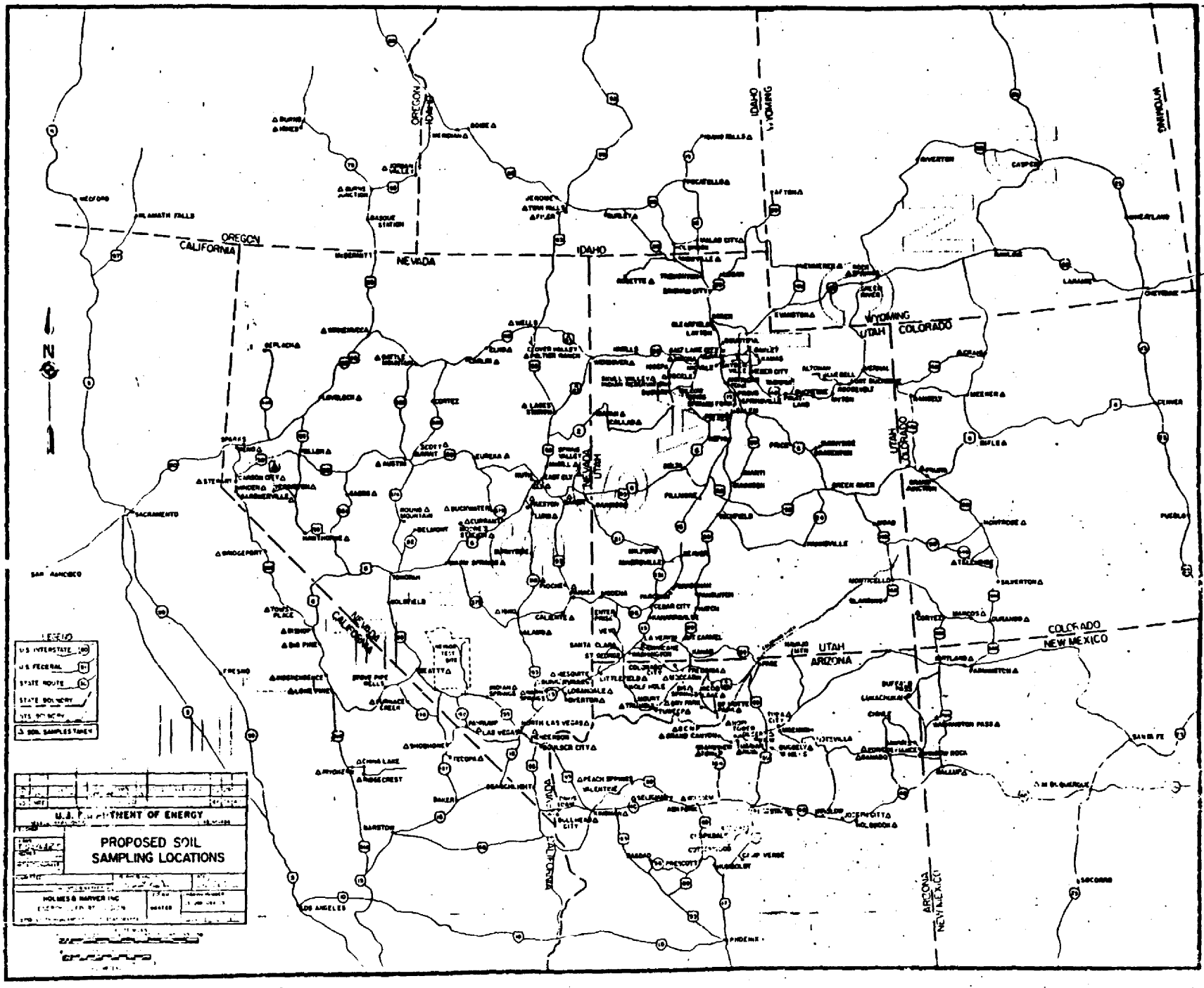
levels to low levels because of rainfall, weathering, and so forth, which would cause them to concentrate in valleys rather than in hills. It would be very difficult to find that out, I presume.

MR. CHURCH: Well, a lot of the Pendleton work was designed to measure just that thing. In the 60s, Bill Wagner's doctoral thesis, which I have a copy of, was published in the early 70s, and that was specifically what he looked at was the migration out of the high Uinta Mountains down into the lowlands. As I recall, his findings were pretty minimal. In fact, he had to look awful hard to try to see anything come down in like 20 miles. He did a lot of ion exchange concentrating out of the streams, just trying to find cesium, as an example. We sampled, in the early 60s, all of the wildlife, vegetation, soil and stuff like that in the high Uintas and found lots of radioactivity in those samples in a comparable sense. I don't think that we ever really saw any evidence of a migrating in a way that would be of much concern. It was hard to find.

CHAIRMAN MOSELEY: Anything further?

MR. BECK: I would just like to remind the Committee that I did report in one of your earlier meetings about our reanalysis of some of the Larson samples from Utah, where we actually got those samples, and we analyzed them for cesium, and, although they were not exactly in the towns, we compared them with the values we got in the nearby towns, and I think you will remember that the values we got were very close to what we would have predicted for that considering the types of samples, and we are still analyzing these samples now for plutonium and isotopic ratios, and we will be reporting on those results in one of your future meetings, comparing the results of those samples with the other results from our own samples.

CHAIRMAN MOSELEY: Thank you very much.

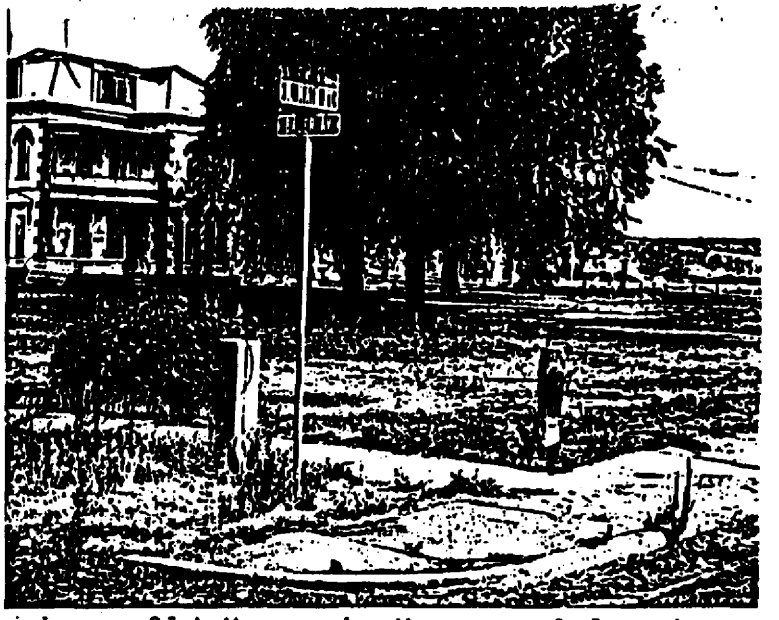

OREGON
CALIFORNIA
NEVADA
IDAHO
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
N
LEGEND
U.S. INTERSTATE
U.S. FEDERAL
STATE ROUTE
STATE BOUNDARY
SOIL SAMPLE SITES
U.S. DEPARTMENT OF ENERGY
PROPOSED SOIL SAMPLING LOCATIONS
HOLMES & NARVER INC

77

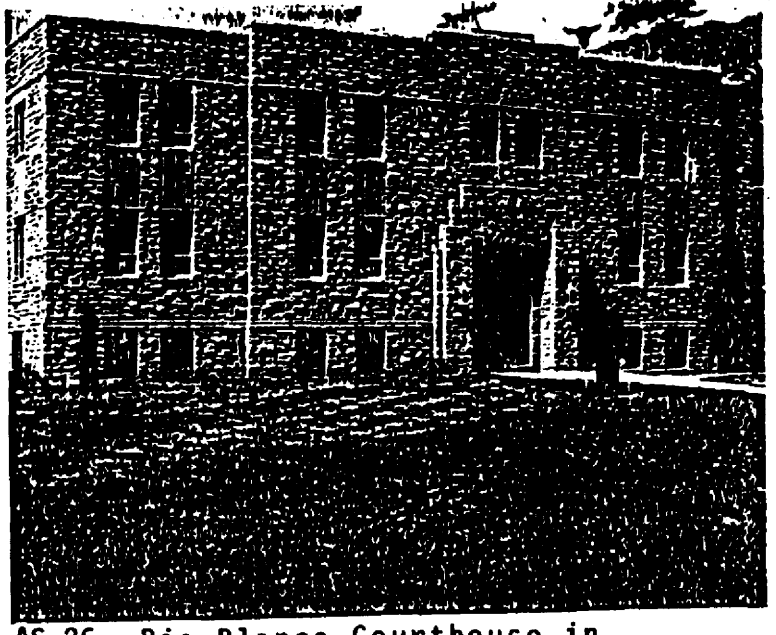
FM-2

Site No. BE-23 Judd Property. Bishop, California.

KS-37 Field behind Hiko Post Office in Hiko, Nevada

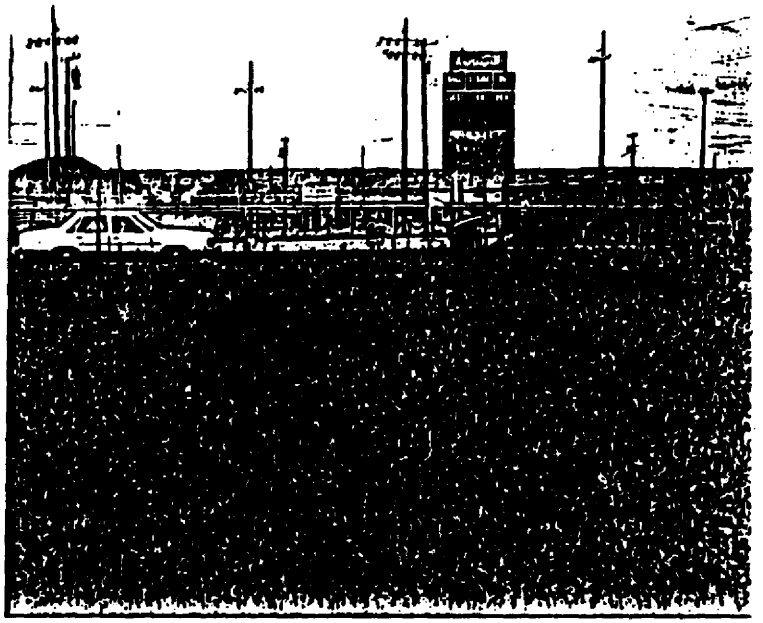


AS-08 - Old House in Mancos, Colorado. 100'x100' lawn.

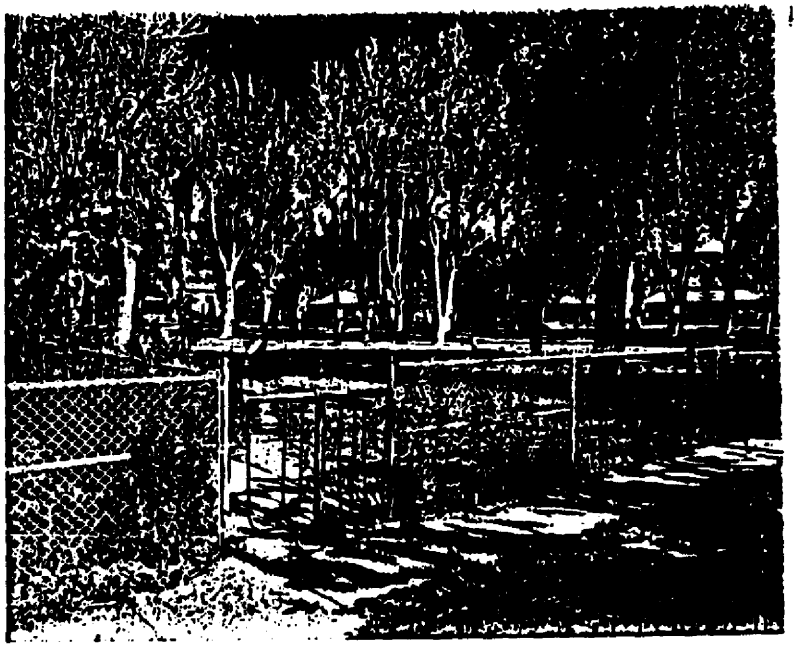


AS-26 Rio Blanco Courthouse in Meeker, Colorado.

AS-06 Montezuma Park, Cortez, Colorado.

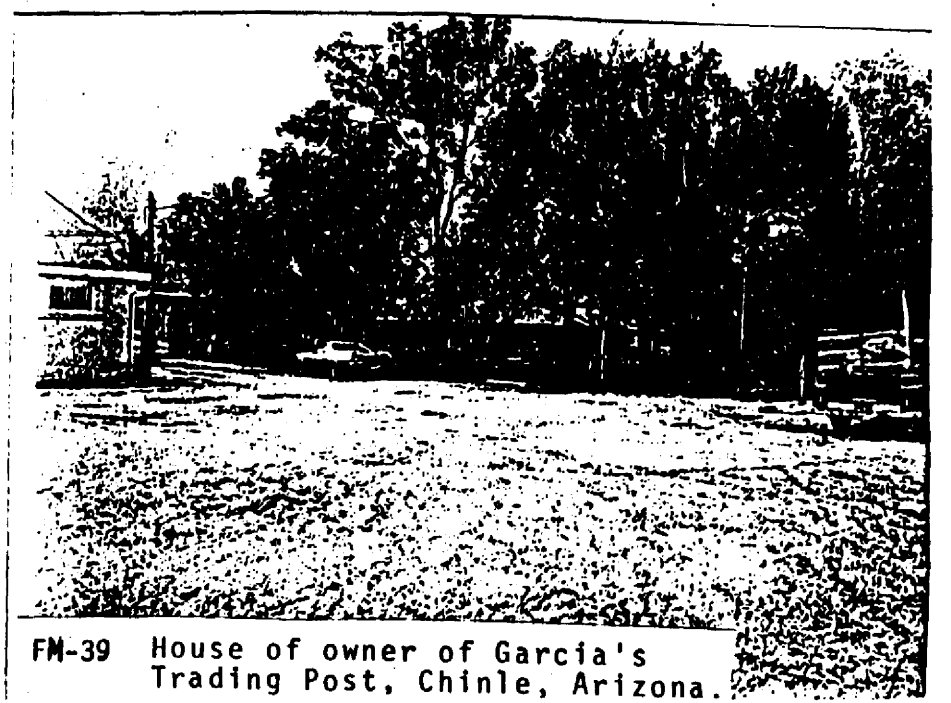


AS-01 Fairgrounds in Farmington, New Mexico.



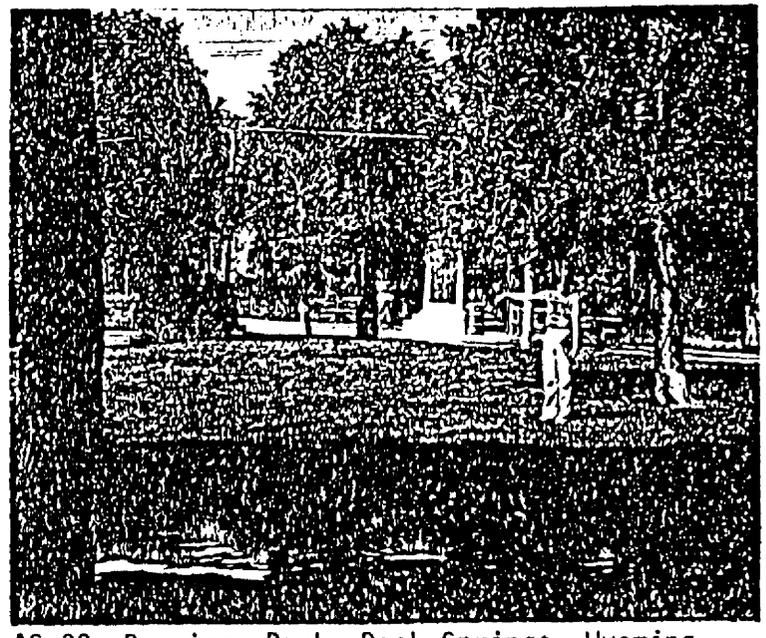
FM-54 Bureau of Indian Affairs Park in Fort Defiance, Arizona

FM-51 Law Offices in Flagstaff, Arizona



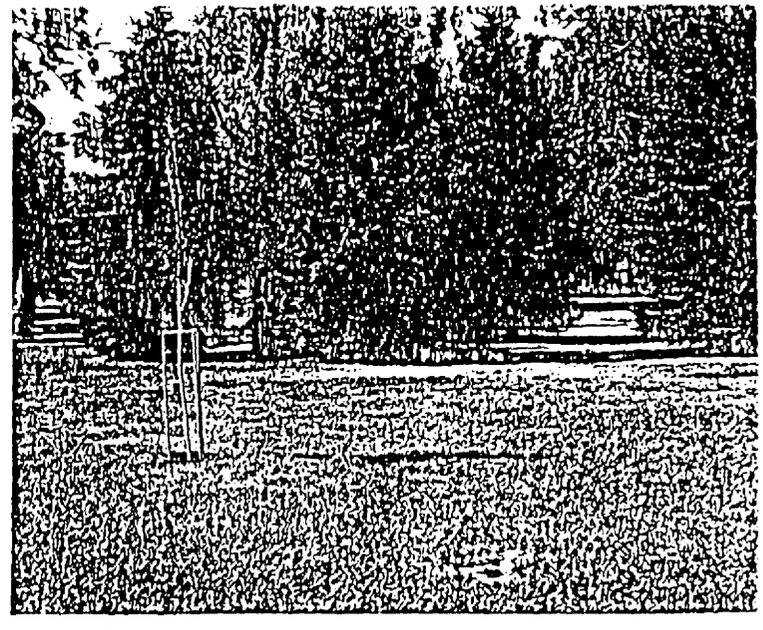
FM-39 House of owner of Garcia's Trading Post, Chinle, Arizona.

FM-12 Open woodland near Tusayan Ruins in Grand Canyon National Park



AS-32 Bunnings Park, Rock Springs, Wyoming.

FM-10 Meadow just off of Grandview Tower Road in Grand Canyon



AS-49 Memorial Park, Pocatello, Idaho.

CHAIRMAN MOSELEY: The next presentation is an expansion on the same subject by John Koranda.

DR. KORANDA: May I have the first slide, Dave. (JK-1). Some of the maps I have may clarify some of the questions that you have just been bringing up about the distribution of sites.

We began the field work on Phase II in July and these numbers differ a little bit from those that Frosty may have given a few moments ago, but that's bound to happen in 300 measurements, and I didn't include the Las Vegas measurements in my totals, but we made fifteen trips during the summer with the help of EG&G's field spectrometer and one person, and Livermore personnel were there. As a result of those measurements, we generated this, I guess, tome is the best word for it, mainly the observations and notes on the field measurements, a few spurious remarks about neighborhood dogs, and we have gone into this and I think Dr. Anspaugh will discuss the use of this tome later on in Site Selection.

Our next slide (JK-2) will show, when it gets oriented right, the distribution of our measurement sites in the western states. This is from a computer map data base. It doesn't clutter up your mind with cities and towns and just shows the states, and you enter it with the longitude and latitude. That's the scene in the area in which we made our measurements, and you can see that it's around the core of Phase 1 sites, which were measured by the EML people. A couple of sites up in the northwest corner of Utah, at Snowville and Rosette were measured by our group.

The next slide (JK-3) shows, I think, just Nevada measurements and over into eastern California, and the next slide (JK-4) will show the New Mexico and Arizona areas.

The next slide (JK-5) just is concerned with some of the basic calibrations that we make on the detector. Before we take it into the

field, we determine the efficiency for various energies directly beneath the detector and the angular efficiency since most of the energy being seen by the detector comes at an angle -- I can't remember exactly where it is, Harold -- somewhere between 30° and 80°, I guess.

The next slide (JK-6) shows the calibration method with the detector hanging on the support there and the sources placed at various angles. We assume that the detector in a hemispheric sense essentially has the same sensitivity.

The next slide (JK-7) I think I will show the protocol of the measurements. We take Frosty Miller's site descriptions which he described a little while ago, and we would usually contact the residents or owner -- they sometimes got disturbed when they saw all of this claptrap set up in their front yard if you didn't contact them, or they weren't home -- and make the measurements, do the site description and mapping, do a few site photographs, and retrieve the equipment and go on our way.

The next slide (JK-8) I think will show some of the -- this is by one of our better ecological artists. These are the kind of measurements we have made to identify the site rather precisely so Howard's people could then come in and locate it. In a few places we placed pegs with a little flag on them so that they could see it. Very often they could see the tripod leg holes in the lawn at the site that we had measured.

This is a page right out of the log book. Yes.

DR. CALDWELL: How often do you have to have it set up?

DR. KORANDA: We are measuring 1,800 seconds, something like that. It takes about 30 minutes.

DR. CALDWELL: It's not set up for 24 or 48 hours. That's what I was wanting to know.

DR. KORANDA: Oh, no.

DR. MCCLELLAN: This one here they had 45 minutes, 16:45 to 17:30.

DR. KORANDA: Yes. That includes set up time and all of that sort of thing. We would still be out there if it were that long a measurement.

The next slide (JK-9). This is a frequency distribution of the total measurements made. I can't say too much about it because it has an unknown horizontal scale, and the units though are in counts per minute of cesium-137. This is essentially the cesium-137 flux, and the data are skewed by some high values, in this case from natural habitats which were measured, and they represent, according to Harold and our own observations, at least a different situation from the idealized site, namely a lawn.

The next slide (JK-10) will show the natural habitat data with the maximum flux here being 85, which I think is what it was on the previous slide for the total data base; and the next slide (JK-11) shows the lawn data which is a little more orderly, but there are a few lawns which we will probably explain with the high concentrations out here when we get the vertical distribution of the radioactivity at that site.

The next slide (JK-12) I think shows the Las Vegas site here at Squires Park with the diodes and the P.I.C. or ionization chamber, and this is our system here which is tethered to a truck, and this is the free standing system which EML has used, and we had -- I think that's theirs, isn't it, Harold? Yeah, that's yours. We were making parallel measurements at this site.

The next slide (JK-13) I think shows the region of interest in that spectrum obtained at that place (Squires Park). People wonder if you can really see it and, of course, with the solid state detector the cesium photopeak is readily discernible even in the presence of high levels of natural radioactivity.

The next slide (JK-14) shows one of our measurement sites over in

California (sic), probably an "A" site with a good, old lawn, relatively well-managed for the area, I guess. You would have to be sensitive to various things like sprinkler systems being put in, which typically have occurred in the last 10-15 years and the trenching that was done to do that. Sometimes the site was disturbed, and it wasn't hardly evident. Sometimes you would see vegetation differences, and it would suggest to you that the site had been disturbed even though the people said that everything was just peachy there for the last 30-40 years; so you had to use a little bit of ecological intuition and observation to really check out the sites.

The next slide (JK-15) I think is over in Nevada where the natural pastures were analyzed with the portable diode system. This is a pulse height analyzer, and this is an extra battery supply. The pulse height analyzer and everything (associated circuitry) is right in that small unit, and it records the data on a minicassette. You get about 10 spectra on the cassette.

The next slide (JK-16) -- I think that's up near McGill -- Here are some of the natural habitat types. This is an open bunch grass underneath a juniper pinion pine woodland on the South Rim of the Grand Canyon. Frosty showed, I think, this same site without the equipment in it. The vegetation cover is not continuous here and perhaps it doesn't satisfy the criteria that Harold's group have set up, but we measured, perhaps, I don't know, maybe 30-40 of these sites during the process of the summer's work. They were ones that were nominated by Frosty, and in this area there weren't any lawns, and so this is about all you had.

The next slide (JK-17) a little more complete vegetated cover in the same region. This was an area where uranium ore trucks stopped in and did some sort of truck servicing and the Park Service had some suspicions that

the area had received some dumping of uranium ore in it. The Orphan Mine is right on the South Rim there, of course, and so we made a series of measurements there in addition to the ones that were nominated by Frosty as being sites for the ORERP program.

The next slide (JK-18). Here's a site that Frosty nominated that we would probably give a "C" or and "X," I don't know. It was a salt marsh, and it shows you the other end of the spectrum of sites in an area that receives little or no rainfall. You have a hard time finding a site to measure. This is a few miles away from Death Valley. We did measure the Lodge lawn there and we got a fairly good value for a place that was 200 feet below sea level and one inch of rainfall a year. Of course, it gets more than that from the hose but the fallout comes via the rainfall.

The next slide (JK-19) is a courthouse in Bridgeport and a somewhat small lawn, but it fell within the criteria. There were some large cottonwood trees here, and, of course, when you look at the trees, as Frosty mentioned a minute ago, 30 years ago their canopies probably did not intercept that large an area, so you have that (time) consideration.

The next slide (JK-20) is the quad at the University of Nevada. Previously it had been rather pristine but in the recent past, it had been stomped and trampled by what looked like scrimmages by the football team, and Howard had some remarks about it when he sampled the soil there, but it was a fairly old area, even though the top few centimeters were chewed up by college rituals or something.

The next slide (JK-21) is a nice scenic site over in eastern Colorado (sic) and a pasture, sort of a meadow-like pasture. It fell into our natural habitat classification. All three of us recognized this basic difference in the sites which, of course, is quite obvious. Nobody is out here maintaining this although some of these sites were irrigated by flood

irrigation and in some cases, even movable sprinklers, but in many of the cases they were just natural meadows.

The next slide (JK-22). Now here is the data base. Here are some of the characteristics of the data base as it resides in the Livermore computer, and we have the identification, the location characteristics and designation, the rainfall as received from Vern and the habitat and site description, and the second value from the bottom there should really be in cpm of cesium because the areal inventory value there is really not valid until we correct the depth distribution function. These are depth distribution. So that's essentially where the data base stands today. I think Howard's going to discuss what followed after our measurements. We were the middle team. The first was Frosty's, and the second team was our group.

CHAIRMAN MOSELEY: Are there any questions?

DR. AUXIER: John, I was just wondering. That photograph (JK-6) which shows the angular distribution calibration detector in the Lab, that was a setup, I presume, just for the photograph? You didn't really do the calibration in the Lab like that, did you?

DR. KORANDA: We sure did.

DR. AUXIER: Well, how did you take account of the fact that as you go around the arc, that the $\frac{H}{D}$ ratio for albedo would vary so markedly with angle?

DR. KORANDA: I don't use albedo in that context.

DR. AUXIER: Well, to say it differently, just say that the room return will vary markedly from -- for instance at the bottom of the arc the source is getting scattering back from the floor much more markedly than it would be over at the 90° angle or 70° angle.

DR. KORANDA: I don't think I can deduce that. Do you have any ideas

on that, Lynn?

DR. ANSPAUGH: We can work some of these calibrations sometimes outside but whether or not that's a particular problem that we ought to worry about some more, I don't know.

DR. AUXIER: We can talk about that later.

CHAIRMAN MOSELEY: Dr. Beck is very anxious to respond.

MR. BECK: What they are doing, doesn't matter. They are looking at the uncollided flux only for this. They are only looking at the uncollided flux.

DR. AUXIER: Oh, the resolution is set for --

MR. BECK: The resolution is extremely high on these detectors. All they are looking at is the uncollided flux of cesium. What happens is that the continuum changes, as you said, but it doesn't affect anything.

CHAIRMAN MOSELEY: Any further questions?

We've got another question. Dr. Wrenn.

DR. WRENN: Just a quick one. Do you have a complete pictorial history of every site?

DR. KORANDA: It's right in here. (Indicates looseleaf book approximately eight inches thick.)

DR. WRENN: I saw lots of buildings with bricks in them, and so I have an ulterior motive.

(Laughter)

DR. KORANDA: Do you want to take this home? I'd be glad to get rid of it.

MR. CHURCH: I think you ought to let them pass that around the table, or at least leave it there so they can spend some percent of the time we do.

ORERP PHASE 2 IN-SITU MEASUREMENTS

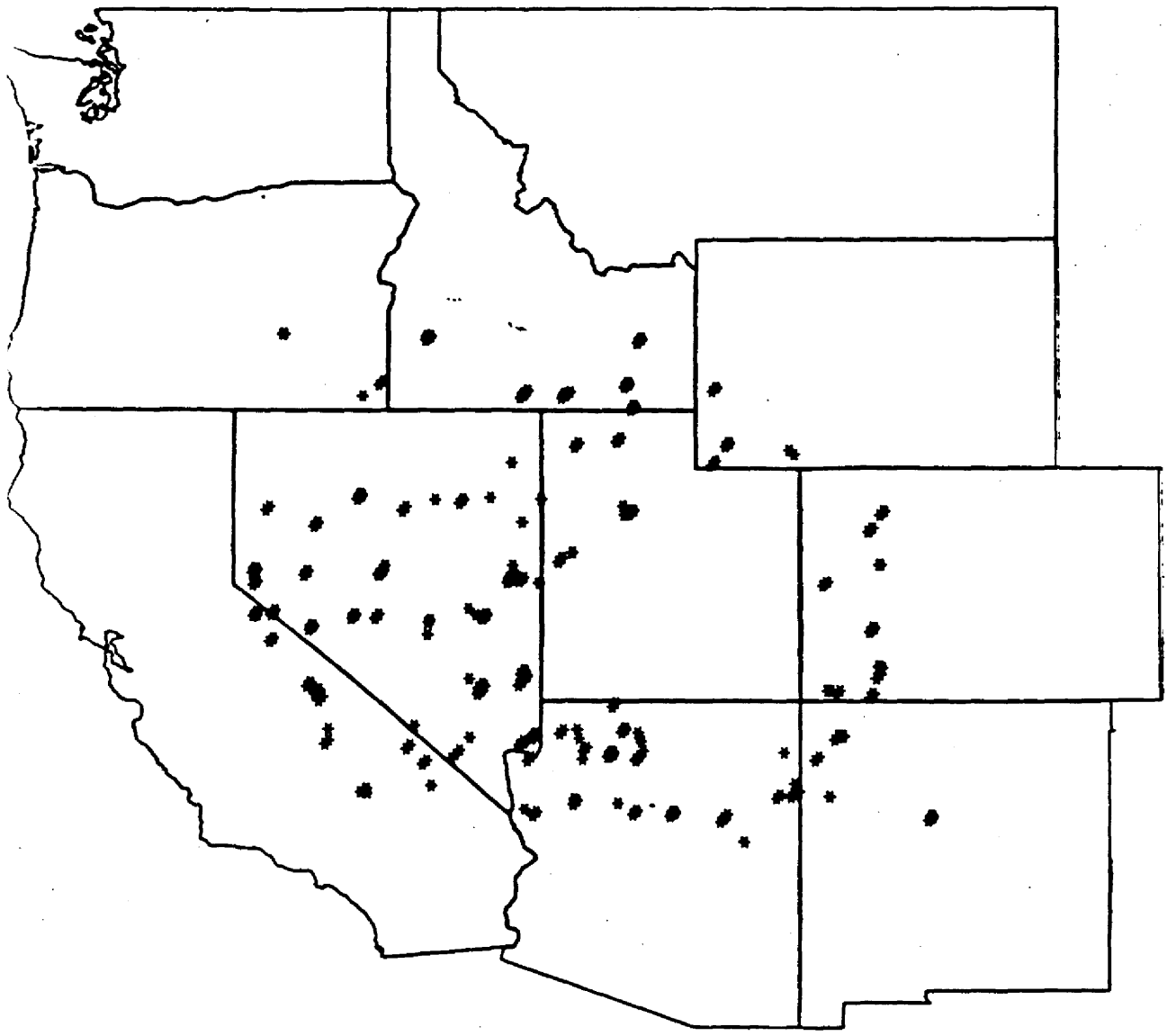
BEGUN 19 JULY 1982

COMPLETED 28 OCTOBER 1982

- **267 sites measured**
- **34 sites rejected**
- **15 field trips**

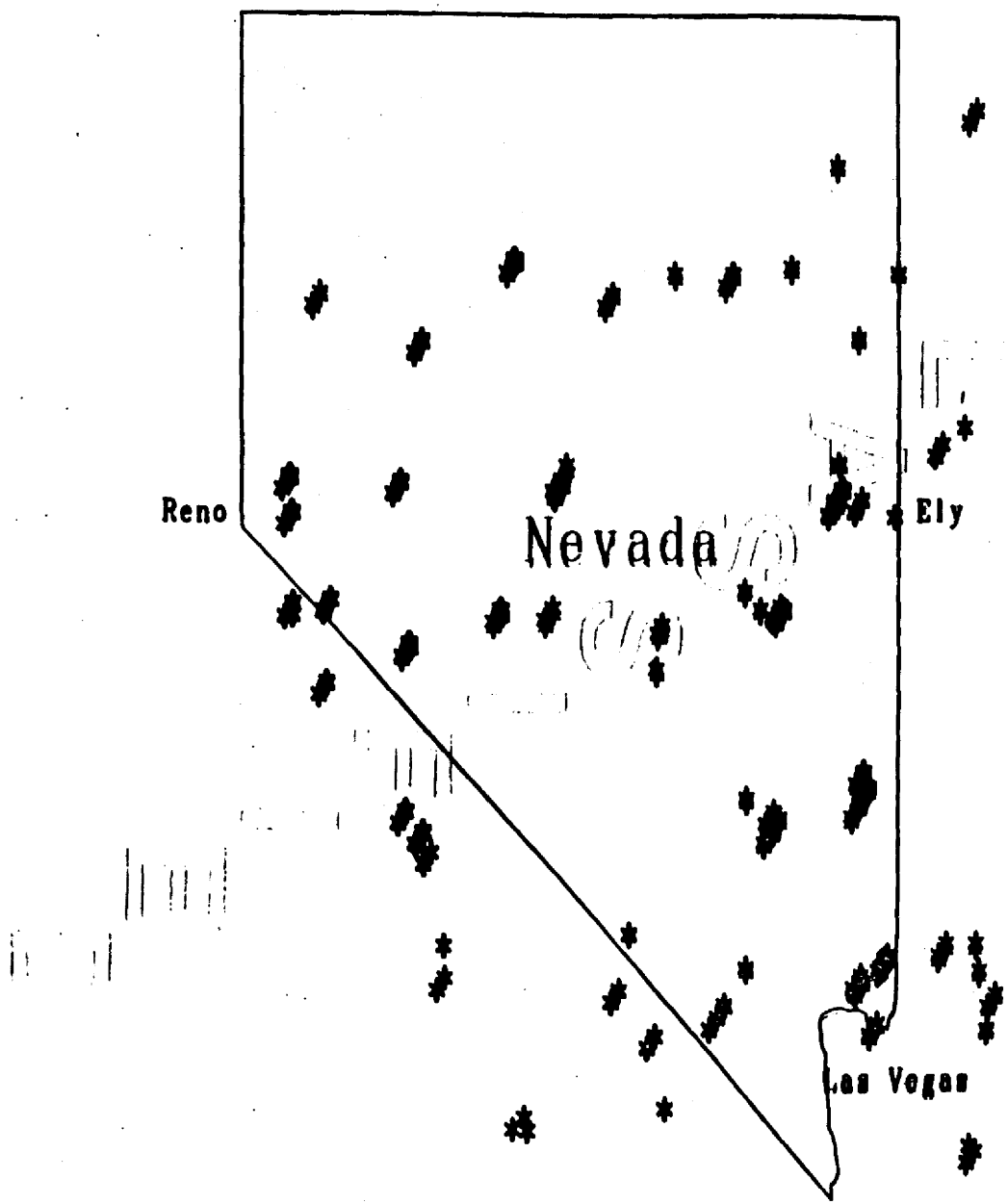
PERSONNEL

L. Anspaugh
B. Clegg
D. Sawyer
M. Stuart
J. Koranda
C. Hall
P. Truelsen
D. Homan

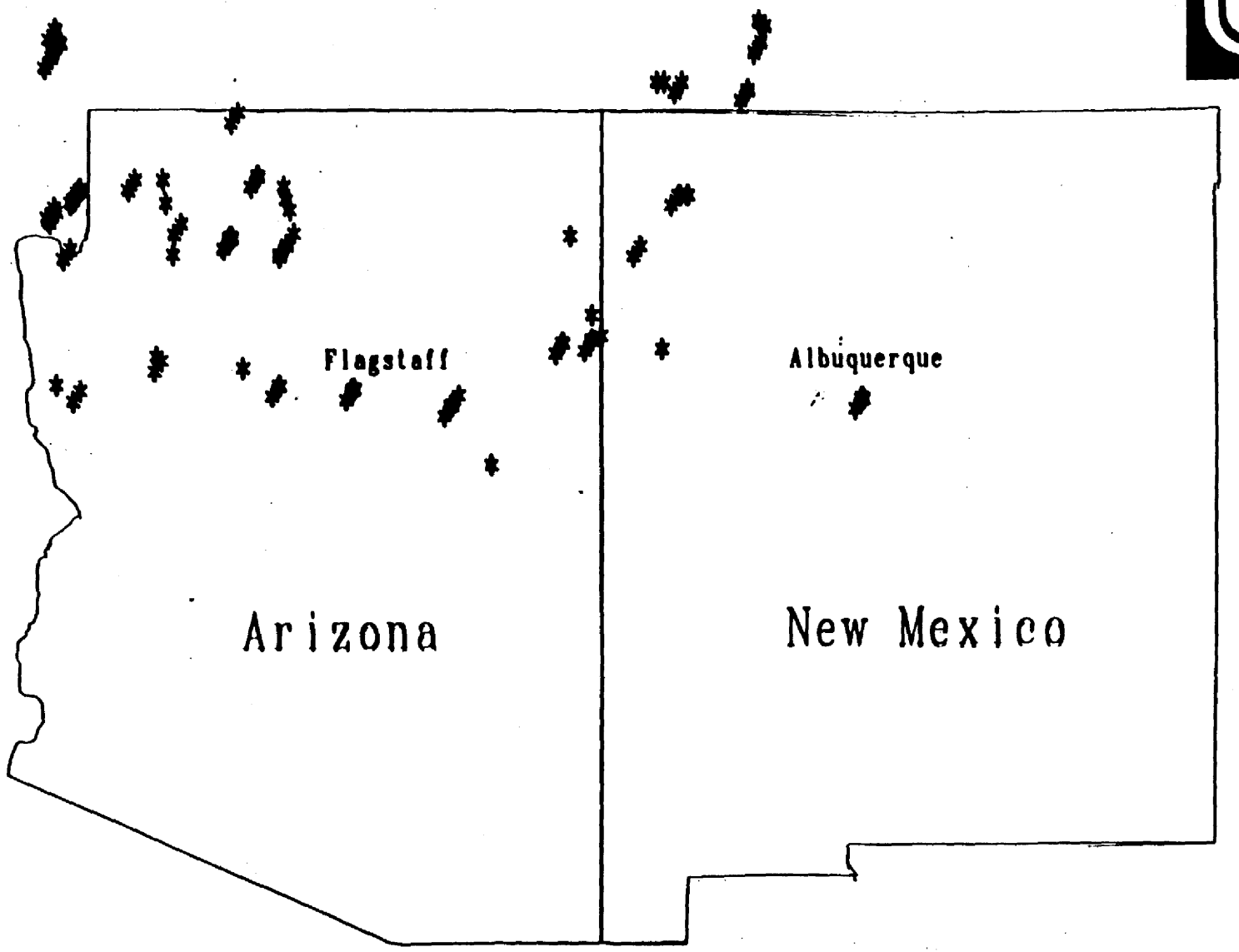


)RERP Phase 2 Collection Sites(1982)

JK2

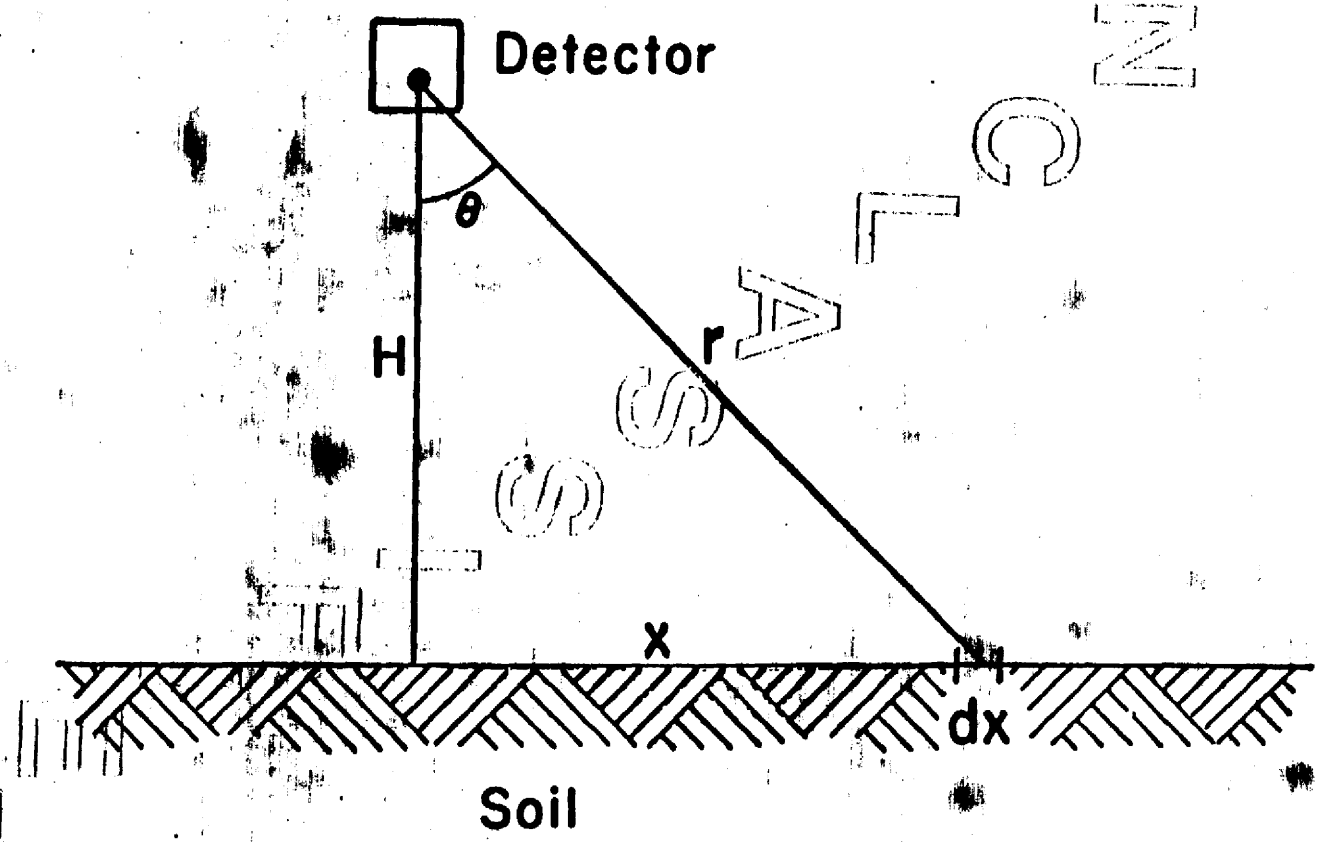


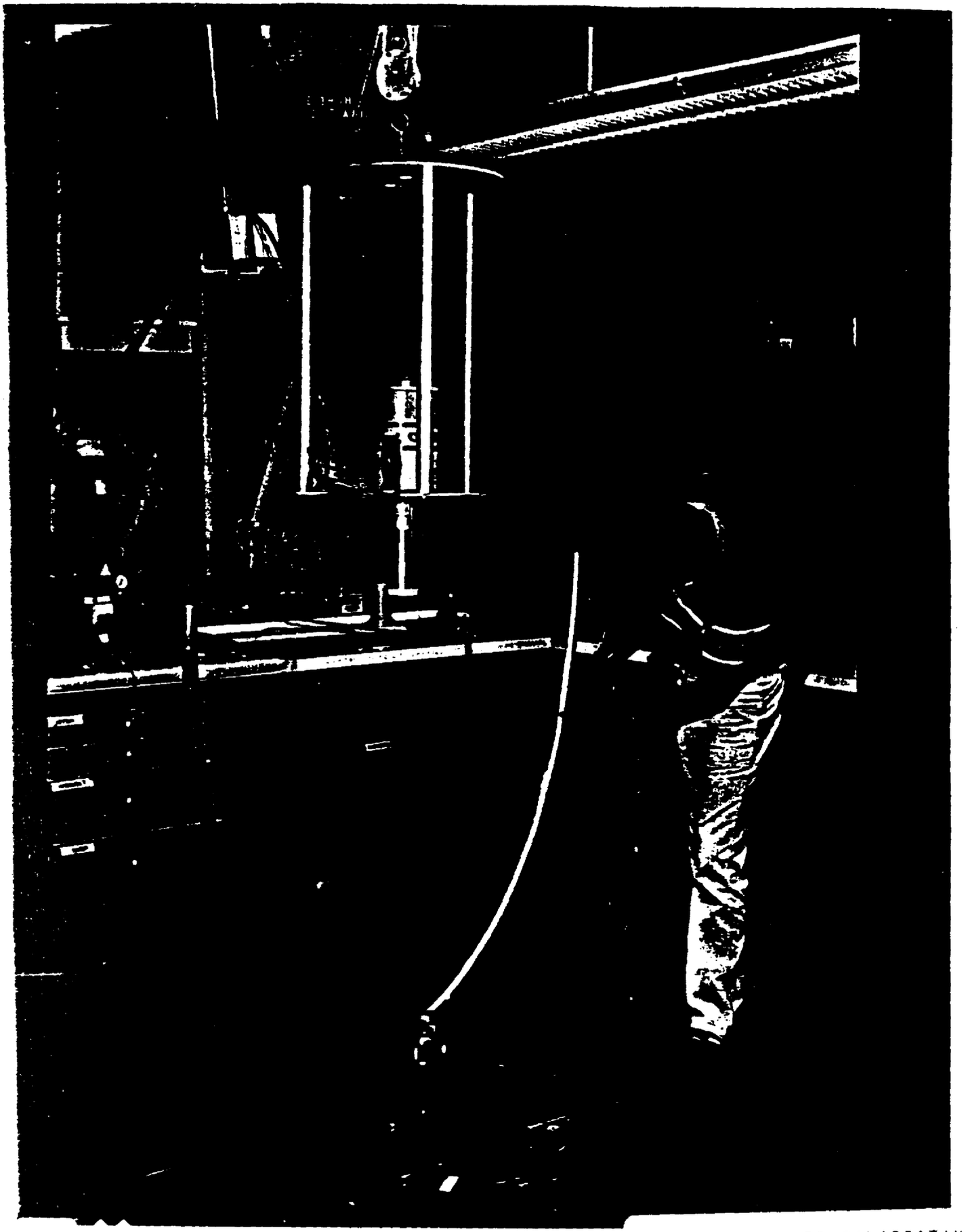
ORERP Phase 2 Collection Sites(1982)



ORERP Phase 2 Collection Sites(1982)

JK-4


Detector
θ
H
r
X
dx
Soil



DOUGLAS SAWYER CALIBRATING
DIODE IN LABORATORY, LLNL

JK-6

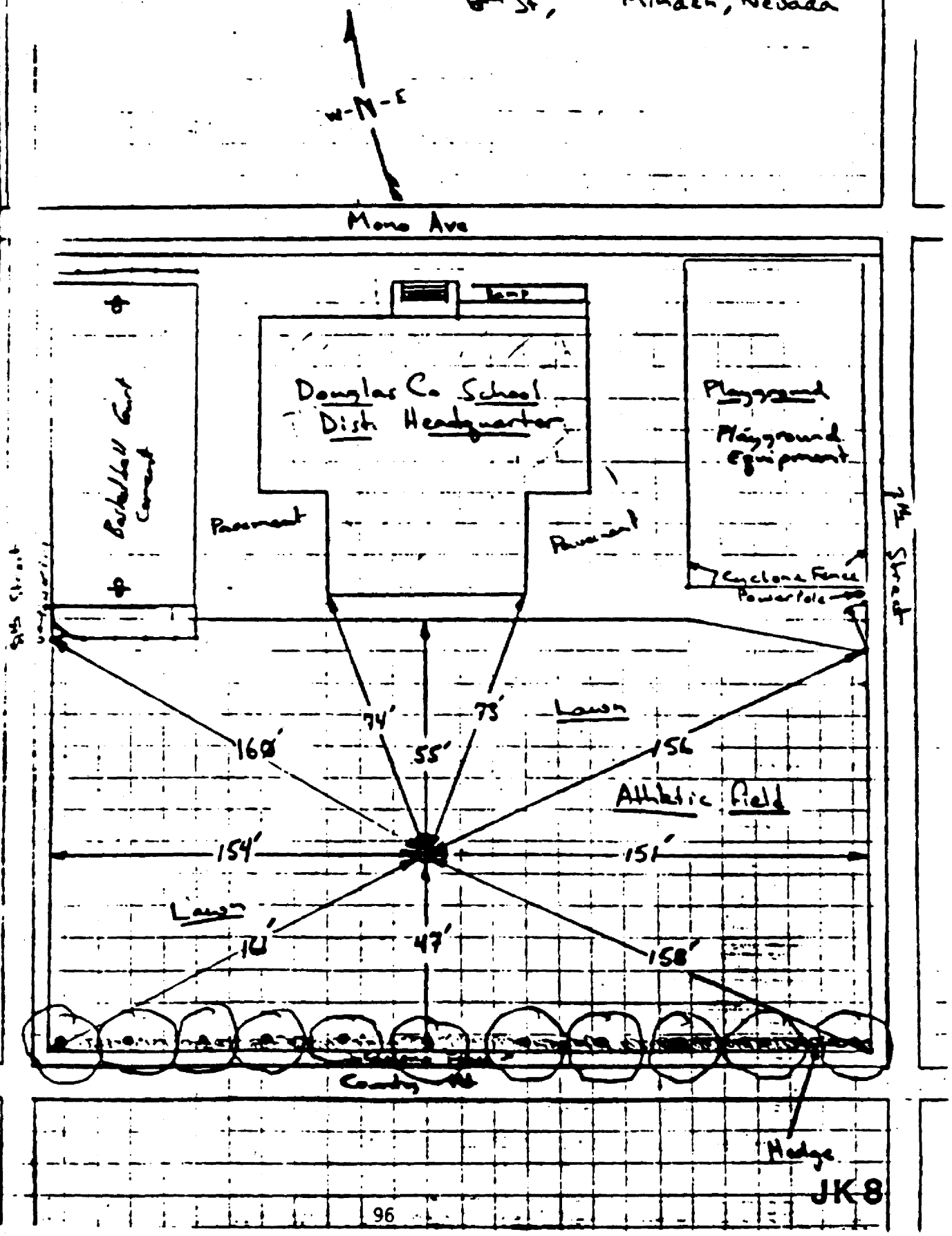
ORERP PHASE 2 IN-SITU MEASUREMENTS

METHOD

- FIND SITE FROM DRI DESCRIPTION
- CONTACT RESIDENTS OR OWNER
- SET UP DIODE DETECTOR, CALIBRATE AND BEGIN MEASUREMENT
- SITE DESCRIPTION AND MAPPING
- SITE PHOTOGRAPHS
- RECORD DATA FROM PHA AND RETRIEVE EQUIPMENT
- SEND SITE DESCRIPTION AND DATA TO REECO SOIL SAMPLING TEAM

Date: 4 Oct 82 Time: 1645 & 1738 hrs Site # GC-42

Location: Douglas Co. School Dist. Headquarters (old middle school) 9th St, Minden, Nevada



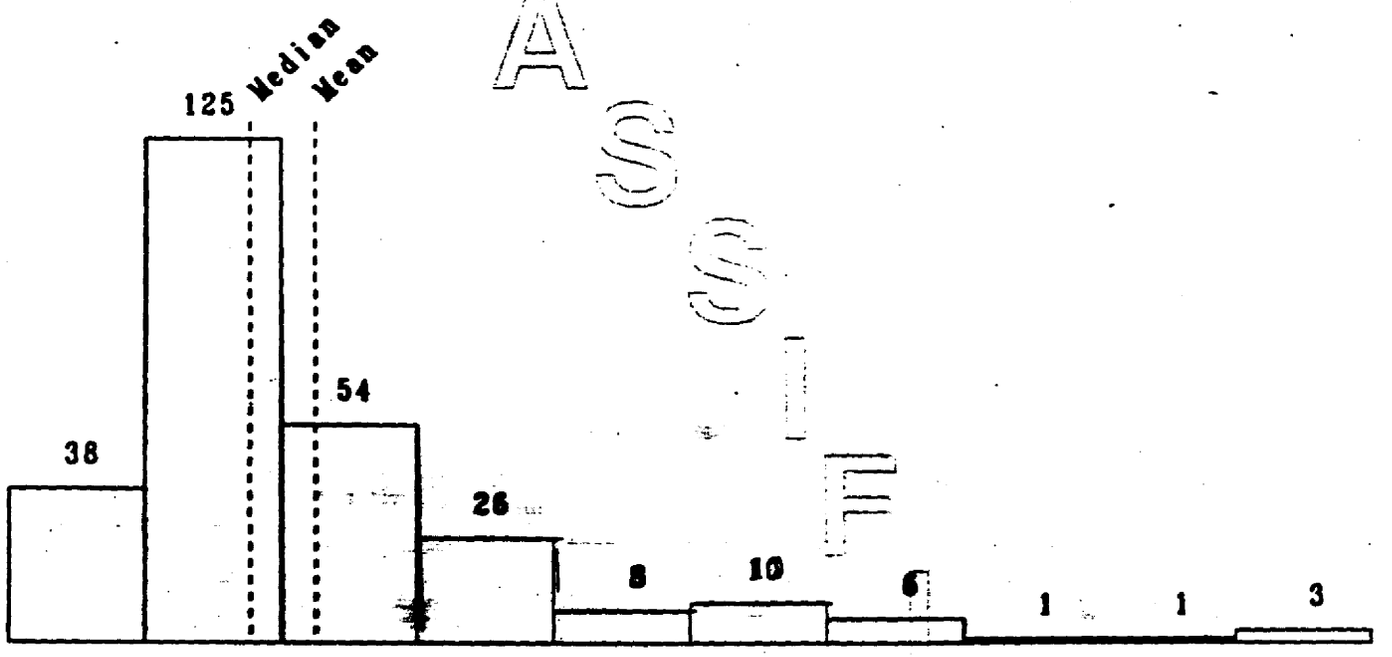
ORERP Phase 2

Number= 272

Median= 1.62e+01

Mean= 2.02e+01 Sigma= 1.35e+01

Geometric Mean= 1.69e+01 Geometric Sigma= 5.85e-01



Minimum= 1.40e+00 Maximum= 8.51e+01

UNCLASSIFIED

JK9

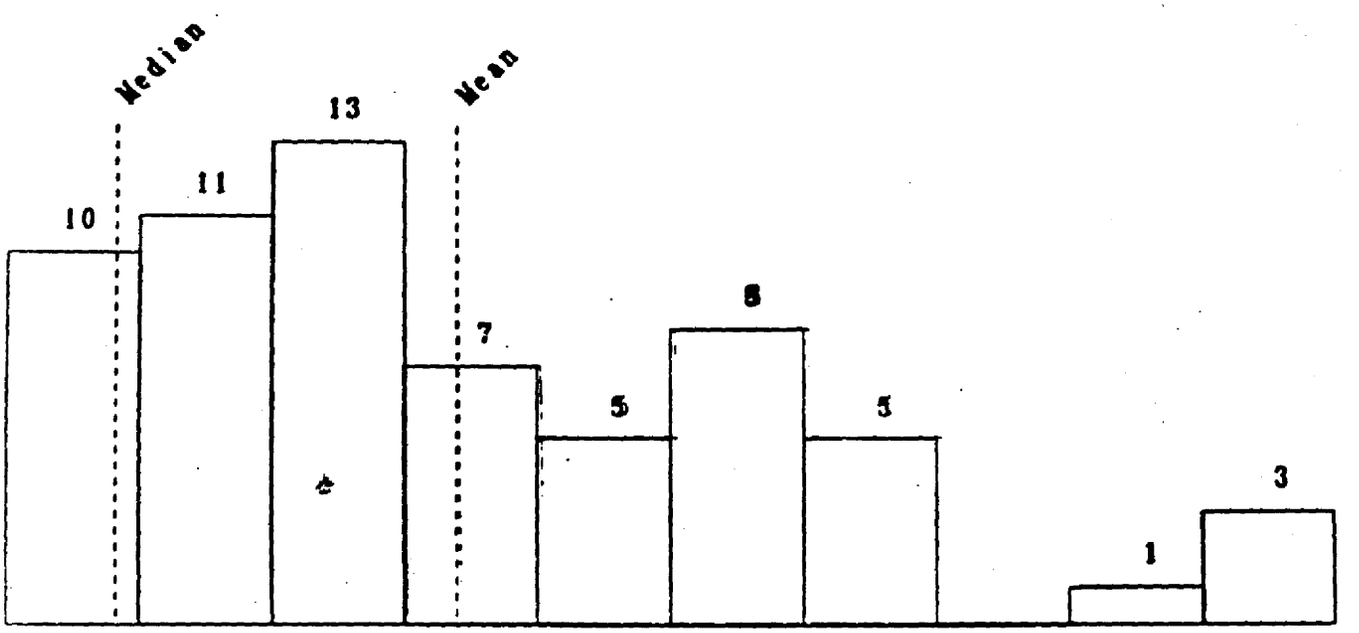
ORERP Phase 2 Natural Habitat

Number= 63

Median= 1.41e+01

Mean= 3.40e+01 Sigma= 1.87e+01

Geometric Mean= 2.93e+01 Geometric Sigma= 5.67e-01



Minimum= 7.80e+00 Maximum= 8.51e+01

JK-10

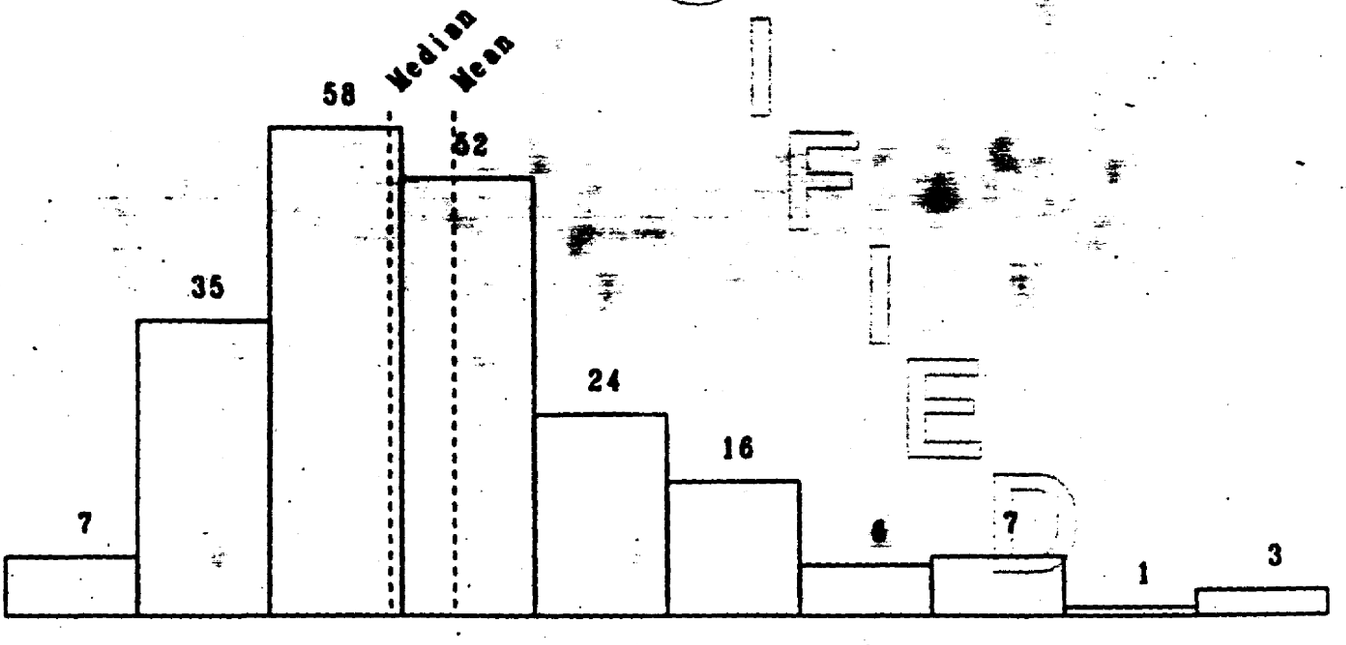
ORERP Phase 2 Lawn

Number= 209

Median= 1.39e+01

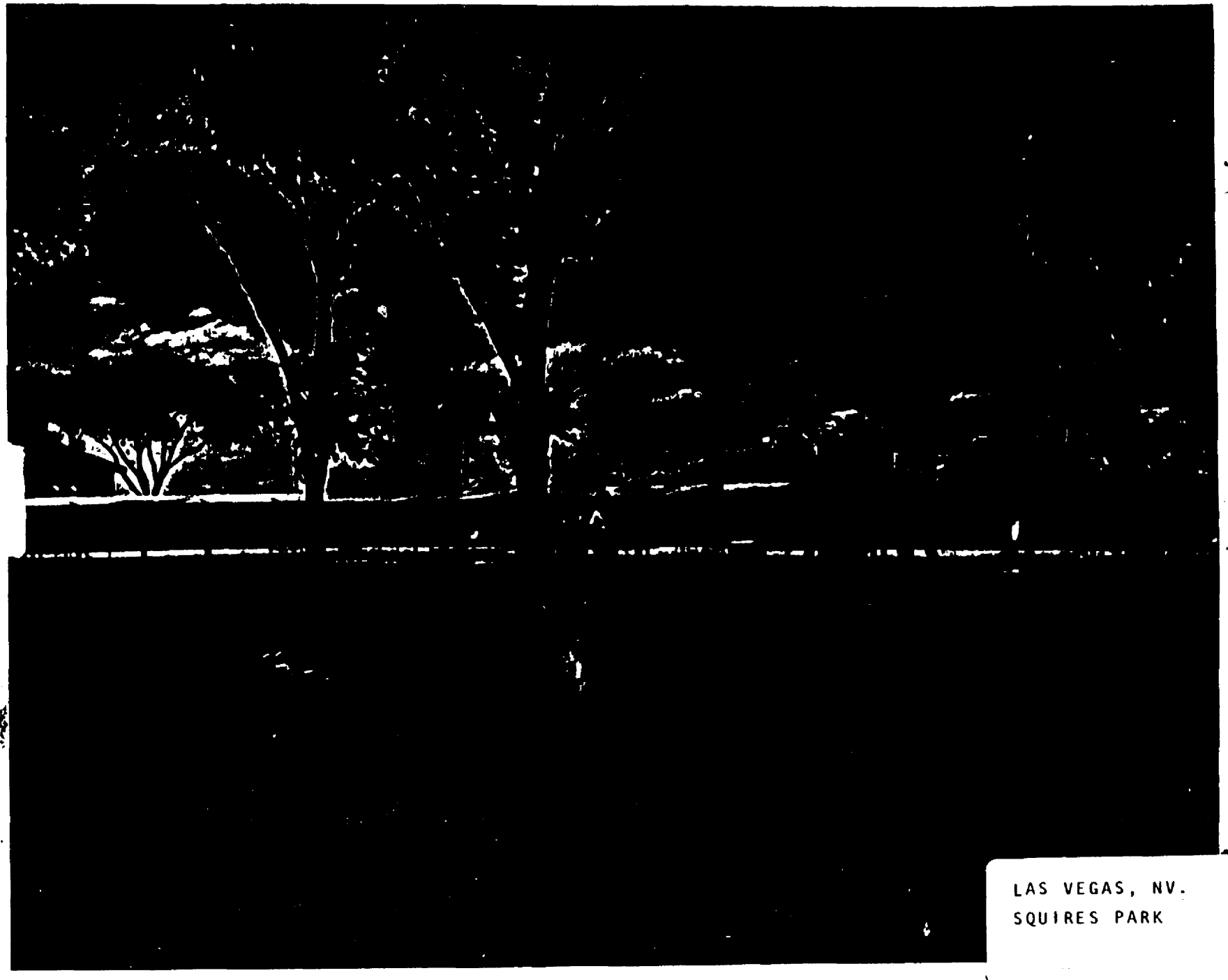
Mean= 1.60e+01 Sigma= 7.49e+00

Geometric Mean= 1.44e+01 Geometric Sigma= 4.82e-01



Minimum= 1.40e+00 Maximum= 4.44e+01

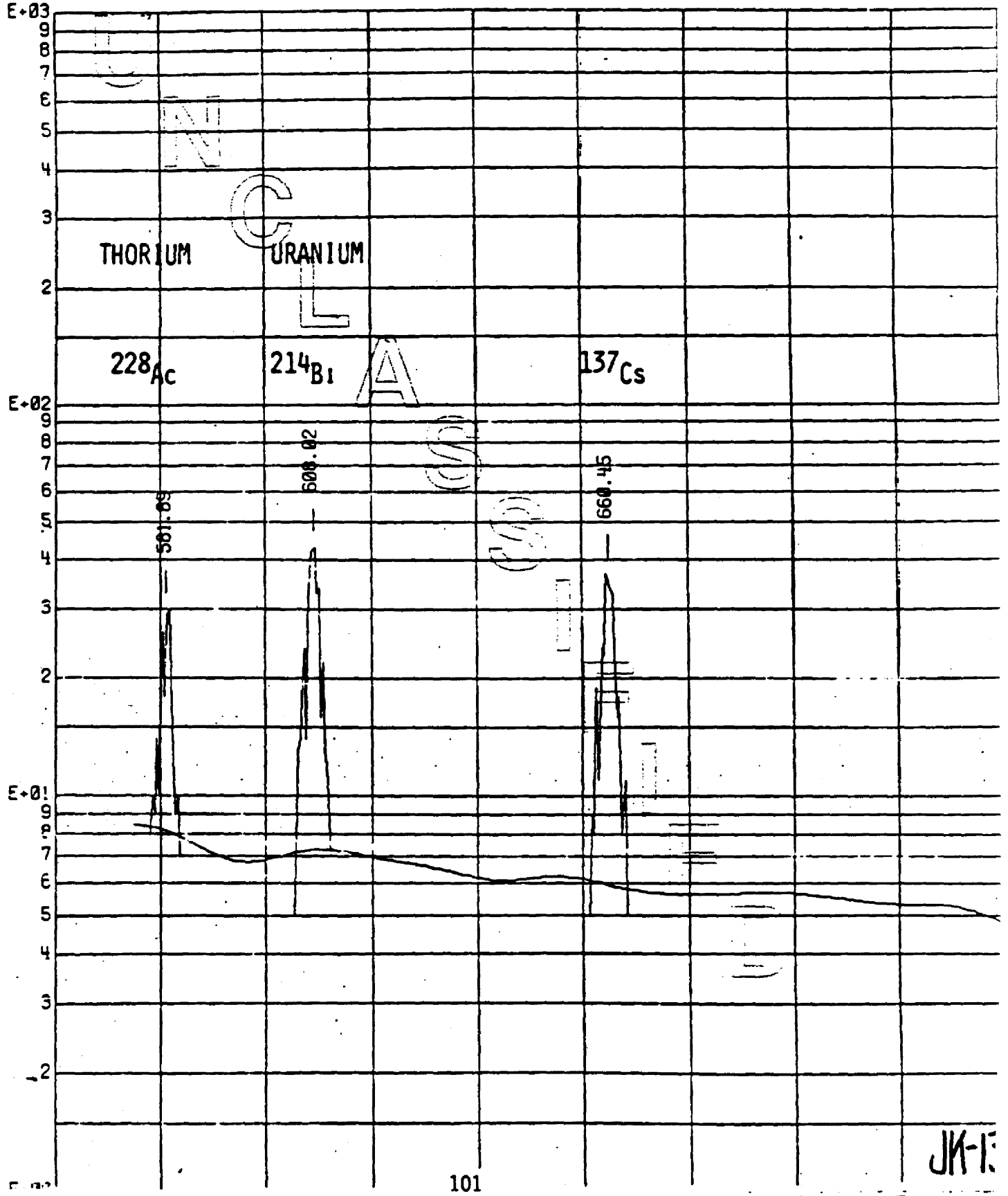
JK11



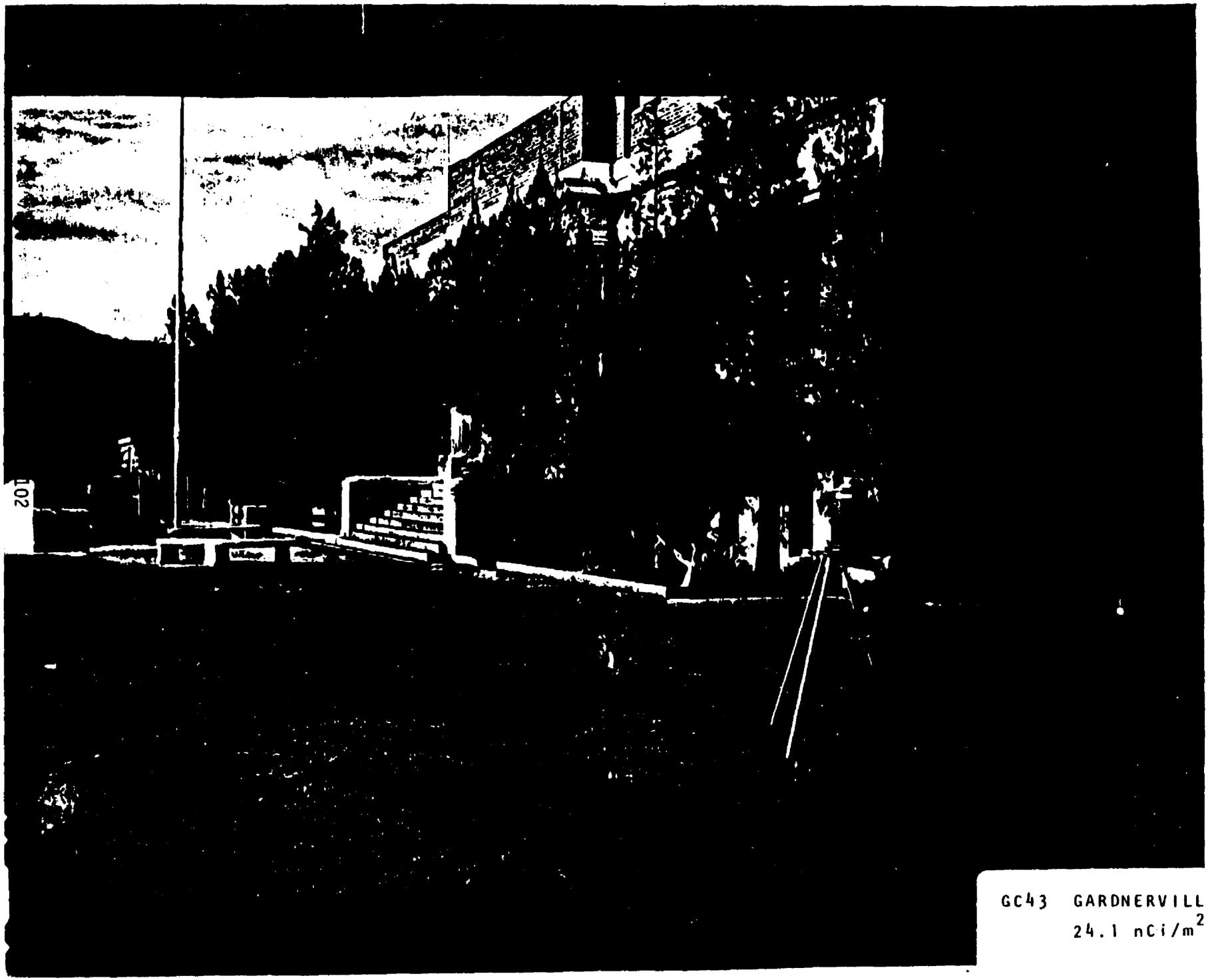
JK 12

LAS VEGAS, NV.
SQUIRES PARK

V8SQUIRE PARK63082 DETECTOR V-8

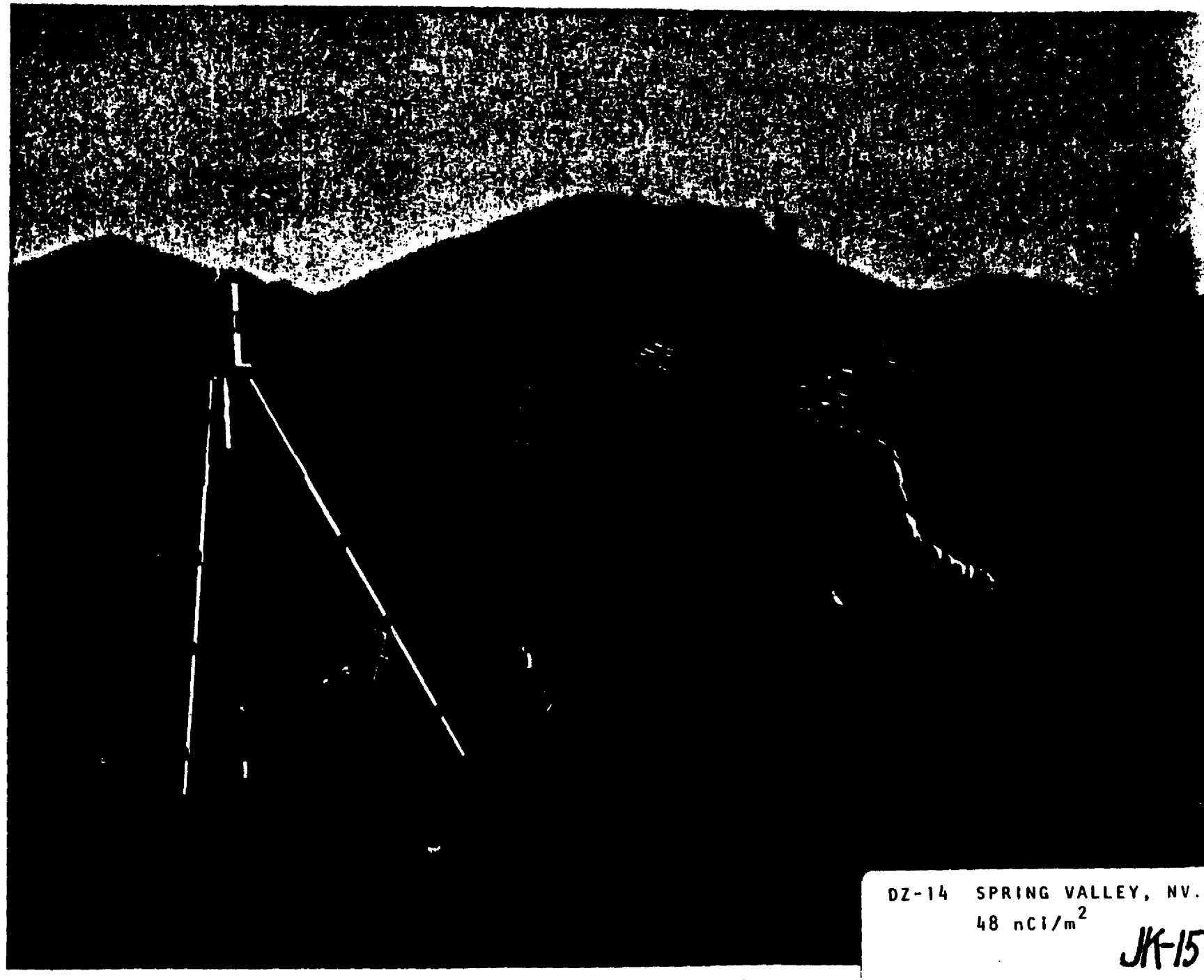


JK-1



JK 14

GC43 GARDNERVILLE, NV.
24.1 nCi/m^2

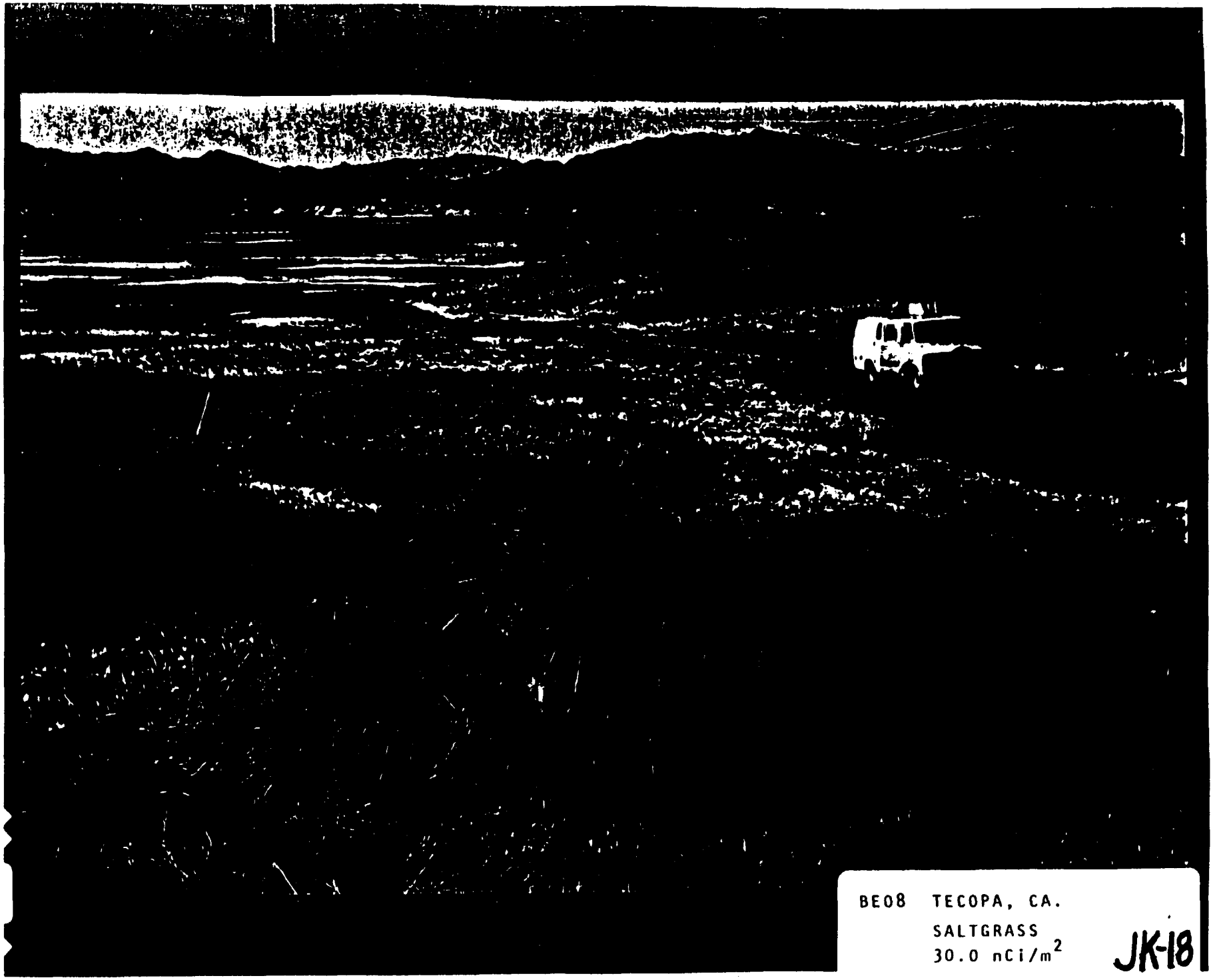


DZ-14 SPRING VALLEY, NV.
48 nCi/m^2

JK-15

JK-16

JK17

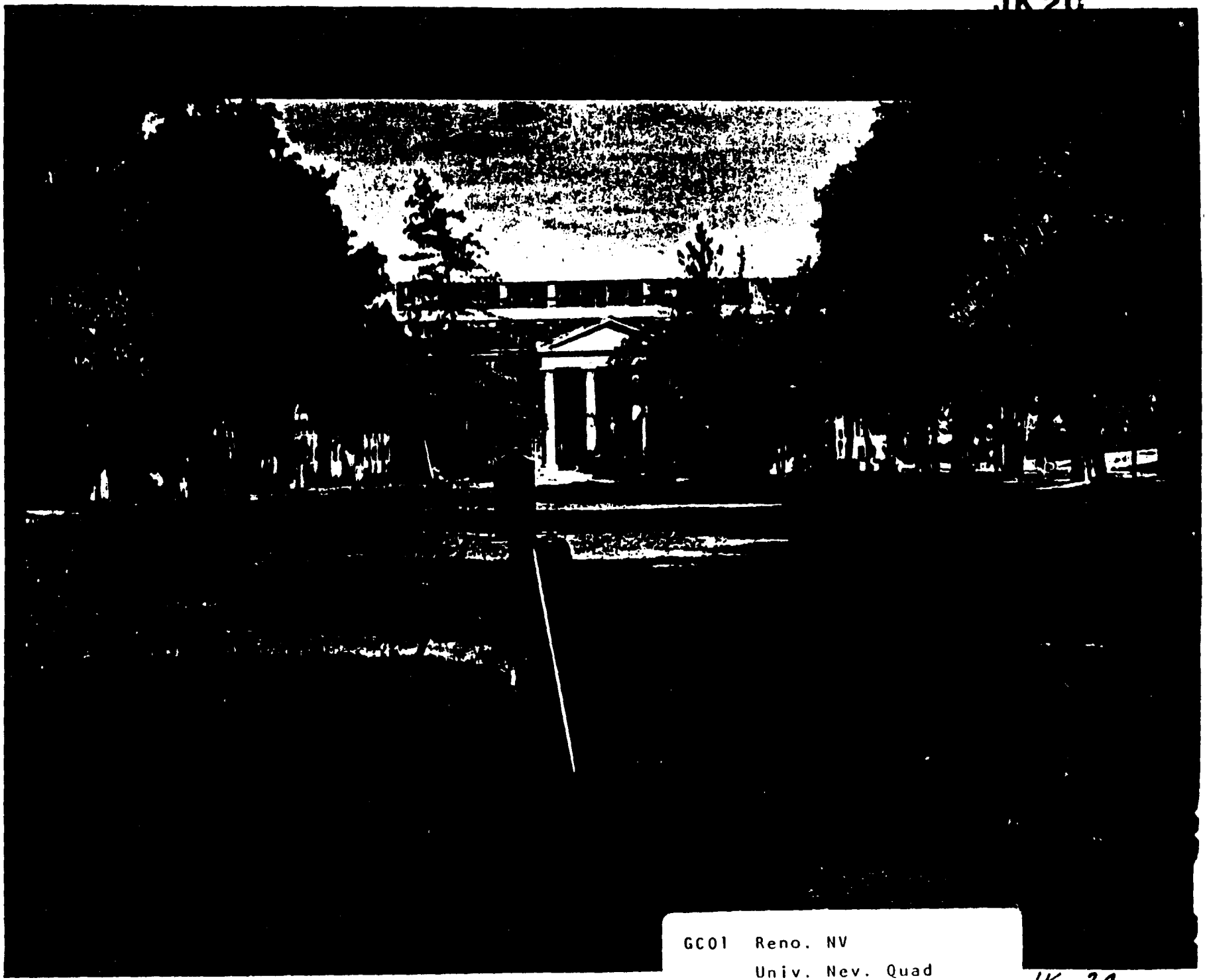


BE08 TECOPA, CA.
SALTGRASS
30.0 nCi/m^2

JK-18

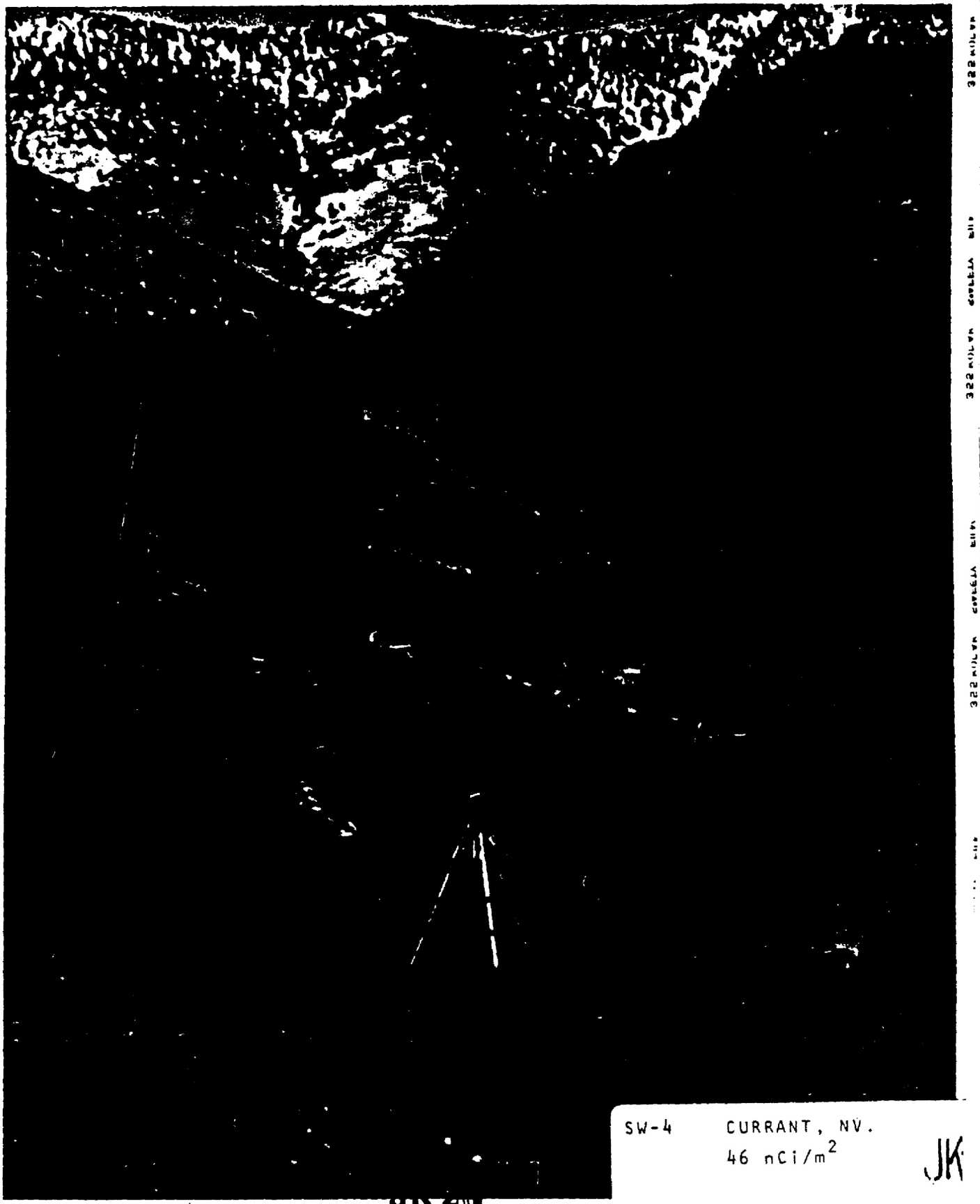
GC29 BRIDGEPORT, CA.
COURTHOUSE
38.1 nCi/m^2

JK-19



GC01 Reno. NV
Univ. Nev. Quad

JK-20



SW-4 CURRANT, NV.
46 nCi/m^2

JK

ORERP PHASE 2 IN-SITU MEASUREMENTS

PRESENT DATA BASE

• IDENTIFICATION	MH22
• LOCATION	BOISE, ID
• LATITUDE	43° 37' N
• LONGITUDE	116° 13' W
• ALTITUDE	2700'
• RAINFALL	12.3"
• HABITAT DESCRIPTION	STATE CAPITOL LAWN
• DATE MEASURED	26 JULY 1982
• PRELIMINARY nCi/m^2	72.8
• SITE CATEGORY	A (SAMPLE SOIL)

JK22

CHAIRMAN MOSELEY: Howard Hawthorne is going to regale us next.

DR. HAWTHORNE: I'm Howard Hawthorne: I usually sit in the back of the room. I'm accused of sitting back there so I can leave early. Bruce will be relieved today to know that I am going to stay for all of this presentation.

Could I have the viewgraphs, please. I'm going to go through the viewgraphs rather rapidly because there are only certain points, and you have copies of them for your later consideration. (REECo 20). We took samples in nine states. We have a little different number of location. We claim 117, and our number of sites remain at 190 as of the end of November. The purpose of collecting the soil cores was twofold: one was to give the validation for the in situ Cesium-137. The second purpose was to derive ratios of Plutonium-239 and -240 from which EML can derive the source of the fallout and the proportions due to NTS.

Our instructions were quite simple: Sample or reject. So we did not make conclusions about the suitability of the spot at which the in situ measurements were taken. We might have grumbled a little, but we didn't really do anything serious about it.

Mention has been made that occasionally we could relocate the marks of the tripods for the in situ measurement. We took our ten-core sample within what Dr. Koranda indicated as the "X" range viewed by the detectors. The difficulty with soil collections is that once you have the specimen in the bag, that's the best that it will ever be. It doesn't matter who does what to it afterwards, it will never get any better than the sample that you took. If the sample you took is not representative, then neither will be the data that you get later; so we go to what may seem to be some extremes in the collection process.

I mentioned, we take ten cores. This goes back a long way historic-

ally. The core cutters take out 8.9 centimeter diameter cores, and the instructions were: collect from grassy lawns. Sometimes that didn't quite happen, and we had to sample where the stake was drawn. John will be glad to know that he can still find some of the places because we couldn't get the stakes out that he drove to mark the spot so we drove it all of the way down, John.

The ten cores represent a fixed area and that area is represented in the collection process by a volume. If the volume is incorrect, i.e., the specimen is too shallow, or is too deep, or is too wide, then the area is misrepresented; and so, as you will see, we provided solutions for all conditions that we came to.

For Arizona (REECo 21), we had 21 locations, 44 sites. A location was defined initially and directed for as a place from which for some reason there was a decision to take samples, and Frosty's group went to the locations and designated the sampling sites.

In California (REECo 21) we have 12 locations, 15 sites. Those of you who are speed readers have gotten over and found there is no REECo 22. Twenty-three is correct. Twenty-two was of interest mainly to us because it showed that at the start of the program we had a few samples collected and by the end of October, we had a lot. I think that sort of is understood.

In western Colorado (REECo 23) there are ten locations, 14 sites. In southern Idaho (REECo 23), eight locations, 11 sites. In New Mexico (REECo 23) five locations, 11 sites. Nevada (REECo 24) obviously got the bulk of the collections, 46 locations, 76 sites. Southeast Oregon (REECo 25), three locations, four sites; Utah, eight locations, 10 sites; and southwest Wyoming, four locations, five sites.

Next figure (REECo 26)). This is a figure made from the data supplied

to us by Dr. Anspaugh for the sites from which soil collections were actually made. The numbers under the graph are the numbers of specimens. The lefthand side gives you the percentages of the sites that fell into one of these concentration categories. As you can see, our figure is quite similar to that of Dr. Koranda's in which he gave a figure representing all of the measurements taken.

Dr. Miller showed the base map. (REECo 27). We have a little yellow dot at each of the sites from which we collected samples. As you can see, Utah has not yet had much attention in this Phase II.

Let's go to the next viewgraph (REECo 28), please. I have divided up the soil collection process into five categories of activities, and these will be illustrated by the slides that are next. Initially we thought that we were going to be able to keep that figure on the screen. We will not be able to.

Soil sampling equipment came in four sizes. (REECo 31) I may lapse and call the three on the left cookie cutters, occasionally, but they are really core cutters, and the equipment on the righthand side is a standard soil auger which collects to 30 cms. This one has a special order barrel which gives a length of 30 cms from the bottom of the cutter to the top of the barrel.

We used color-coded buckets (REECo 32) into which the increments went because sometimes it's a lot easier to see a color than it is to find the number on the back of a container. It also helped us keep the cores that went into a particular increment separate from cores from some other increment.

(REECo 33). The first thing that we needed to do after we had gotten to the site was to find where Livermore had taken their readings. There is actually a tape measure lying on the ground between the tree and Nancy

Rothermich. Nancy, who is back in the audience, and Bernie Maza took most of the samples that were taken, sometimes together and sometimes with another team member.

(REECo 34). We had a horror of losing a specimen or getting one mislabeled. The first thing we did was to make out an ID tag which went into a little ziplock baggy. The baggies went into the bottom of the large plastic bag in which the specimen was collected.

(REECo 35). There was a question raised about site identification. We're taking a polaroid picture there, and -- I'm sorry, that's a 35-mm. We took 35 mm from three different positions taken with the idea that the person looking at the picture would be guided in getting back to where the sample site had actually been. We also took a polaroid picture of the site where the holes were actually made for future reference in terms of later assessments of the suitability of the microsite.

(REECo 36). We start down in the sampling. This is a 0-5 cm core cutter. You can see its relative size compared to the gloved hand. (REECo 37). We drove the core cutters down with a hammer. At one time these were actually collected by standing with your heels on the edge of the cookie cutter which is a very precarious place to stand. It goes a lot faster if you can drive the cutter into position. You need to be careful that you pound equally on both sides of the handle so that your cutter is driven vertically.

(REECo 38). EML sent us a steel driver which was very useful in a number of locations. The gloves become very much appreciated along about 3:30 on the afternoon of the first day of hammering. The midsize cutter (REECo 39) and the long one (REECo 40). This one goes down to 15 cms. The normal procedure would be to take the 0-5 cm core, then the 5-10 cm increment, and finally, with this cutter, the 10-15 cm increment in all of those

places designated as grassy lawns. For locations which could not be called grassy lawns, we were under instructions to cut the top increment at 2.5 cms, divide it into the first and second increments, collect the 5-10 cm increment as the third sample, and go with the soil auger (REECo 41) from 10-30 cms. The vegetation at this particular site is rather heavy. This makes problems which we will address a little later.

(REECo 42). If the breakoff point for the increment is deeper than it should be, we trimmed, using the base of the core cutter as a guide. The excess material, we dropped into the next lower increment. Cleaning the cutters sometimes gets a little strenuous (REECo 43). Here an eight-inch knife is going in after the core. Another way (REECo 44) was to pound on the outside with a rubber mallet. There is a degree of photographic license in some of our slides. Normally we did not hold the cookie cutter up in the air and thump it. It was down in the bucket when it got pounded on.

This (REECo 45) is the auger we showed earlier. It is a neat fit inside the hole made by the last and longest core cutter. We knew we were at 12 inches or 30 cms when the top of the barrel was even with the surface we had designated as our zero starting point. Sometimes you could pour the soil out; sometimes you had to pound it out.

We come now to some of those special places which were sort of skipped over by Frosty. John Koranda showed a horrible example that looked like it came off the salt beds at Death Valley. Fortunately we didn't have many of those, but we had solutions for all of the kinds of sampling sites that we came to. These (REECo 46) are some of the tools, knives, spatulas, and, occasionally, (REECo 47) hammer and chisel.

(Laughter)

The chisel has a little extra flourish. You can use it in a very grassy

site (REECo 48) to twist out the core cutters. Sometimes (REECo 49) you just have to go to it, and if this happened, then the criteria scheme came into action later. As the cores were taken, each increment was recorded in the bound notebook (REECo 50), and its history was written right there as you did it, not after you had done seven of them, or all 10, and were back in a motel, but as each of the forty core increments was taken, the notes were made in the book.

This (REECo 51) wasn't really how we found many places. We probably had two cases out of a thousand increment cores where this arose. The problem is that there is no problem getting the core cutter out. It will just come right out, but nothing comes with it and so the solution there (REECo 52) is to pour some water on it. We would pour a small amount of water around the cookie cutter to maintain the integrity of the hole we were making and some water into the cookie cutter itself, let it infiltrate for a short period of time, and then (REECo 53) go in from the other end of the cookie cutter and take the sample out with a spatula from the top. Fortunately, we didn't have a great many of those, but it is possible.

Sometimes you could get the feeling when you started to lift on the core cutter that nothing was coming with it. In those cases we would go back in and tamp the soil (REECo 54) that was supposed to have been coming up. Usually we could get it. If you had a super-reluctant specimen, then we could resort to wetting it (REECo 55) and tamping it.

In terms of data recording (REECo 56), I have already shown you the card in the baggy that has a full description of the increment including those persons who are later to be considered either heroes or villains and the date on which they made the collection. The soil is poured right into the large specimen bag on top of that small baggy, and we write another description (REECo 57) with almost the same information that is on the card

across the closure label with a flowmaster.

We took polaroid pictures (REECo 58) as I mentioned earlier, and those right at the time got stapled to our logbook, as is happening here (REECo 59). The logbook (REECo 48) at the time that you are ready to leave the site had a hand-drawn map, had a polaroid picture of the microenvironment at the sampling site, the pertinent information describing its identification, and the ten core descriptions. This one looks like it probably was an "A" according to our criteria. Please bear in mind that our criteria are connected to the vertical dimension and not to the surface conditions and their suitability or unsuitability.

Once you have gotten your sample, the next thing is to clean up and everything got washed. We washed the large cutters (REECo 60), and the small cutters (REECo 61); we washed them on the inside (REECo 62), and we washed them on the outside (REECo 63). Last of all, don't forget to do the buckets (REECo 64). In terms of walking away and leaving a mini-driving or putting range in place, we avoided that by collecting soil (REECo 65) which was tamped into the holes as they were filled (REECo 66) so that when we left the site, the surface had been restored at all of the locations (REECo 67). Unfortunately, we don't know how that worked because we haven't been back to look at them.

The happy part comes when you load it all back into the vehicle and this (REECo 68) is what you had better get back to the lab with when you have been out on an expedition.

We move now to the criteria. If you would go back to -- as I mentioned, our criteria dealt with the vertical dimension of the soil samples, and our rating scheme started, you might feel, in reverse. We noted all of those conditions which might have impaired the volume representing the area or which could have contributed to

cross-contamination of the material. There was an automatic "C" rating if the sidewalls of the holes collapsed and fell into the hole, and if after several attempts at other locations to collect samples we were unsuccessful, then we would say that was a "C" site. There is likely to be transfer of material vertically that was not at the lower level when we came to the site. If we were unable to collect a full 30 cms, that also gave an automatic "C" rating.

If extraction of the samples required use of any of the special techniques, that also was considered very seriously. A "B" rating came from those places where some of the holes had stones that had to be extracted manually. There was an automatic presumption that we cross-contaminated the lower sample, or if most of the cores needed to be trimmed indicating that an excess of material had come up the first extraction. If none of these things happened, then we rated it as an "A" site; so, our criteria and our rating do not have the same quality, I might say, as those done by DRI and by Livermore.

That concludes the collection process. You may be wondering what those other two pages are. Those are for my next presentation which deals with soil processing. They are all attached together. It may not have been a good idea, but it seemed like a good idea at the time. Are there any questions?

CHAIRMAN MOSELEY: Are there any questions on this aspect?

DR. WARD: What kind of an array do you have for the ten samples that you take around the centerpoint? I didn't see a plan view of the holes, or is there but one?

DR. HAWTHORNE: Normally it was linear, straight line.

DR. WARD: I see, march along in one direction.

DR. HAWTHORNE: We tried to drive the stake where we thought the

centerpoint for Livermore's equipment was. That would be number 5 or number 6 in our line and approximately 14-16 inches apart for the cores.

DR. WARD: If one were to repeat your work, you would want to do the same thing.

CHAIRMAN MOSELEY: You'd have to have that sample if you repeated it very precisely.

DR. WARD: That's one of the hazards of perfection.

CHAIRMAN MOSELEY: We will take a 20-minute break and start again at 10:40.

(SHORT RECESS)

REECo Soil Collections through November 1982

STATE	LOCATONS	SOIL SITES COLLECTED
Arizona	21	44
California	12	15
Colorado	10	14
Idaho	8	11
New Mexico	5	11
Nevada	46	76
Oregon	3	4
Utah	8	10
Wyoming	4	5

Totals:

Number of States =	9
Locations =	117
Soil Collection Sites =	190

REECo Soil Collections in Arizona through November 1982

Bullhead City	1
Chinle	1
Flagstaff	6
Fort Defiance	2
Fredonia	1
Ganado	2
Holbrook	1
Jacobs Lake	1
Joseph City	1
Kingman	2
Littlefield	2
Moccasin	1
Mt. Trumbull	1
North Rim Grand Canyon	5
Peach Springs	2
Sawmill	1
Seligman	1
South Rim - Grand Canyon	7
Tuba City	1
Tuweep	2
Williams	3
Totals: 21 Locations	44 Sites

REECo Soil Collections in California through November 1982

Big Pine	1
Bishop	2
Bridgeport	1
China Lake	1
Furnace Creek	1
Independence	1
Inyokern	1
Lone Pine	2
Ridgecrest	1
Shoshone	1
Tecopa Hot Springs	1
Tom's Place	2
Totals: 12 Locations	15 Sites

REECo Soil Collections in Colorado through November 1982

Cortez	1
Craig	2
Durango	2
Fruita	1
Mancos	1
Meeker	1
Montrose	2
Rifle	1
Silverton	2
Telluride	1
Totals: 10 Locations	14 Sites

REECo Soil Collections in Idaho through November 1982

Boise	1
Burley	3
Filer	1
Idaho Falls	1
Malad City	2
Meridian	1
Pocatello	1
Twin Falls	1
Totals: 8 Locations	11 Sites

REECo Soil Collections in New Mexico through November 1982

Albuquerque	5
Crystal	2
Farmington	2
Gallup	1
Kirtland	1
Totals: 5 Locations	11 Sites

REECo Soil Collections in Nevada through November 1982

Alamo	4
Austin	4
Baker	1
Battle Mountain	1
Beatty	1
Big Smokey Valley	1
Boulder City	1
Bunkerville	2
Caliente	1
Carson City	3
Clover Valley	1
Current	1
Duckwater	1
Elko	1
Ely	5
Eureka	1
Fallon	2
Gabbs	2
Gardenerville	2
Gerlach	1
Hawthorne	2
Henderson	2
Hiko	2
Indian Springs	1
Lages Station	1
Las Vegas	1
Logandale	1
Lovelock	2
Lund	1
Mesquite	1
Minden	1
Moores Station	1
North Las Vegas	2
Overton	
Panaca	2
Pioche	2
Preston	1
Reno	6
Spring Valley	1
Stewart	1
Warm Springs	2
Wells	1
Winnemucca	1
Yerington	2
Totals: 46 Locations	76 Sites

REECo Soil Collections in Oregon through November 1982

Burns	1
Hines	1
Jordan Valley	2
Totals: 3 Locations	4 Sites

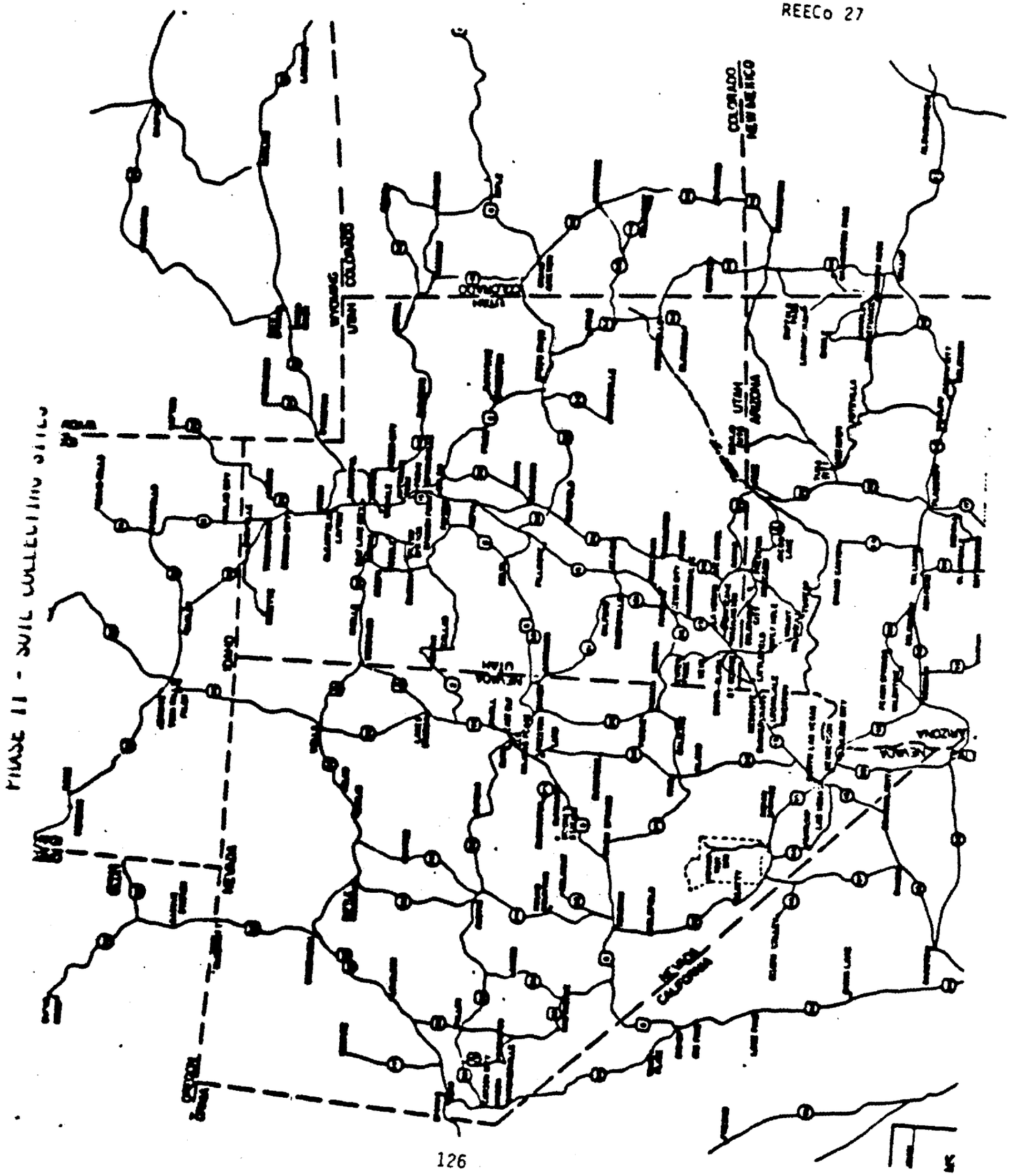
REECo Soil Collections in Utah through November 1982

Callao	1
Ibapah	2
Iosepa	1
Rosette	1
Skull Valley	1
Snowville	1
Tooele	2
Wendover	1
Totals: 8 Locations	10 Sites

REECo Soil Collections in Wyoming through November 1982

Afton	1
Evenston	1
Kemmerer	2
Rock Springs	1
Totals: 4 Locations	5 Sites

REECo 26
LLNL in situ cesium-137 (nCi/m²)
0.
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
170.00
180.00
190.00
200.00
PERCENT OF 190 SOIL SITES
COLLECTED BY REECO
0
5
10
15
20
25
30
35



- TOOLS AT REAR OF ROOM
  - 3-CORED INCREMENTS TAKEN
  - REVALUER TO 30 CM BY SOIL AUGER
  - INDIVIDUAL BUCKETS FOR EACH INCREMENT
- IN SITU TRIPOD SETTING RELOCATION
- SELECTION OF CORING DEVICES FOR SITE: LAWN TO 15 CM, PASTURE TO 10 CM
- PREPARATION OF LABELS FOR SITE BY INCREMENTS AND PHOTOS

COLLECTING SOIL CORES

- CORED INCREMENTS: CUTTING SOIL AND ROOTS
  CORE EXTRACTIONS
- AUGER USE: LAWNS: 15-30 CM, NON-IRRIGATED: 10-30 CM
  - SPECIAL TECHNIQUES

SPATULA WITHOUT PLANT COVER 0-2.5 CM

TURNING AND CUTTING ROOTS

TAMPING LOAMS

WETTING SANDS AROUND HOLE AND IN CUTTERS

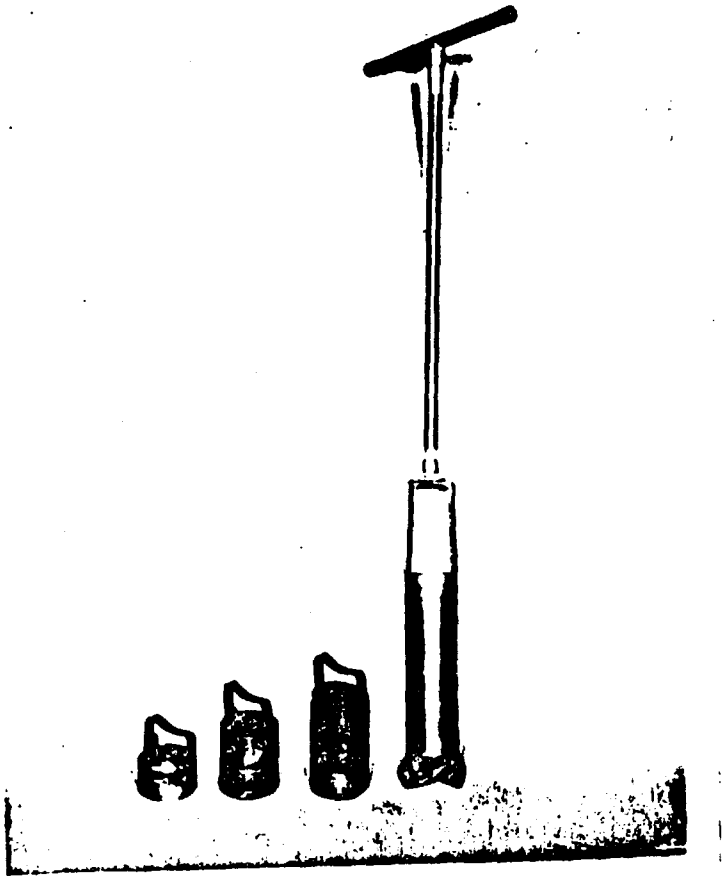
CHISEL AND HAMMER FOR ROCKS

REMOVING ROCK FROM HOLE

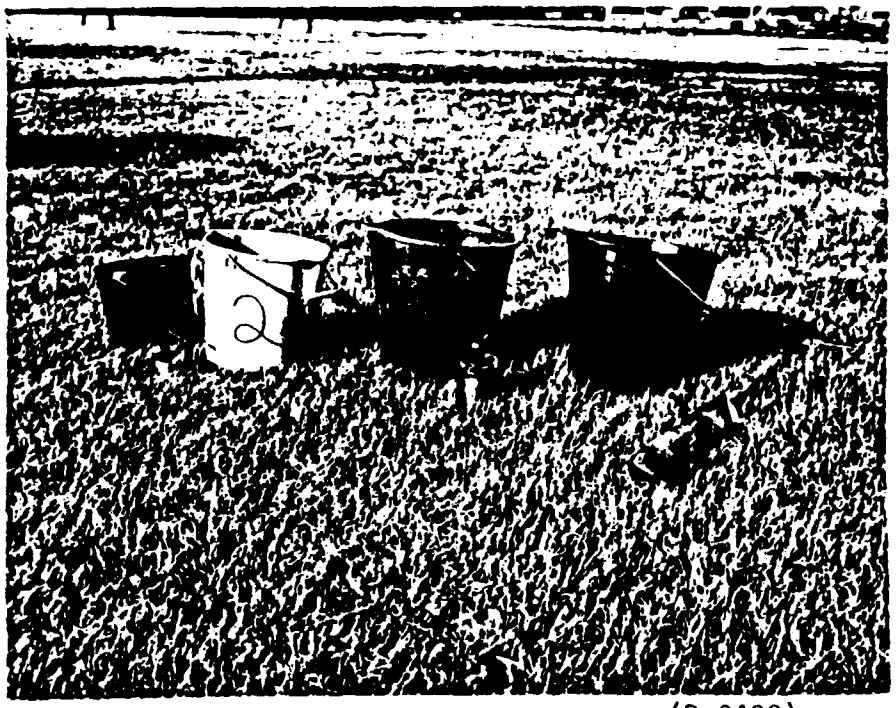
DATA RECORDING

CLEAN-UP PROCEDURE

SITE RESTITUTION

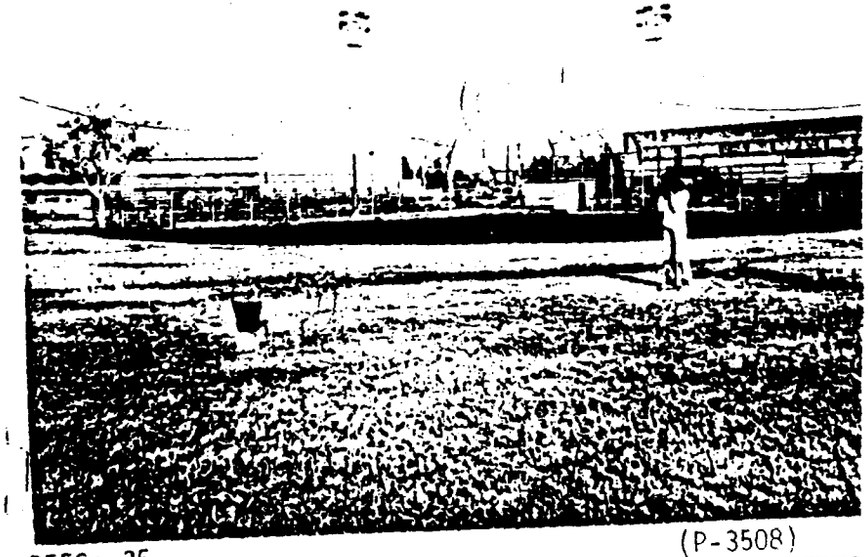


REECo-31 (P-3473)



REECo-32 (P-3490)

REECo-33 (P-3507)



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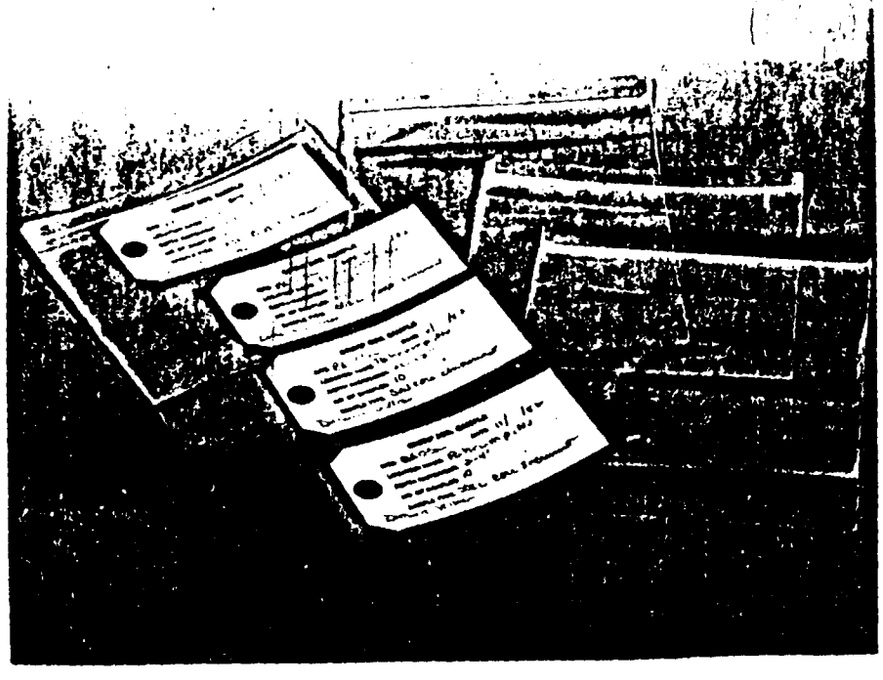
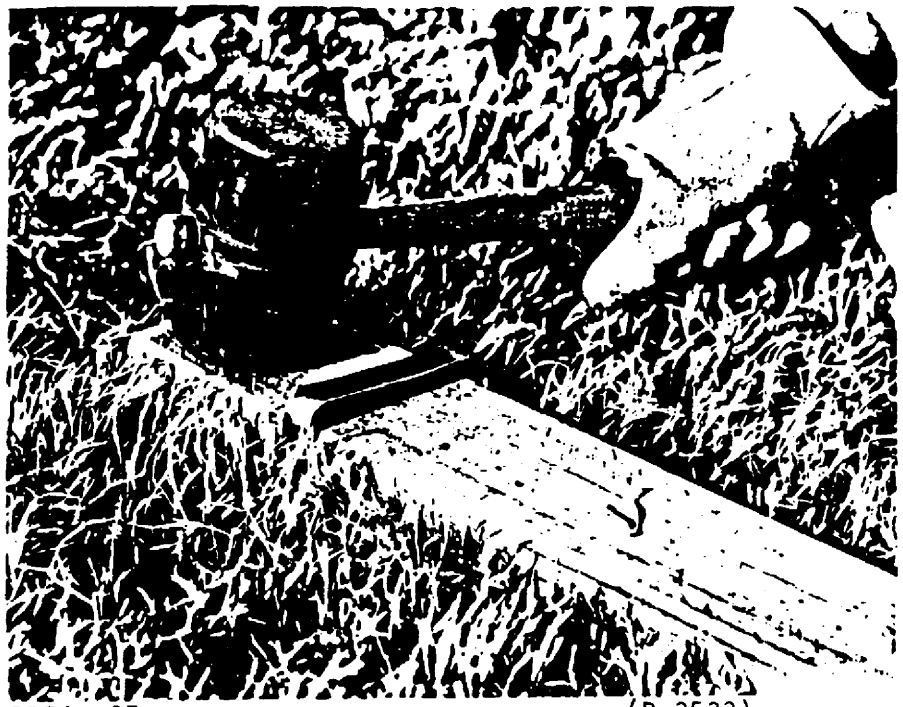


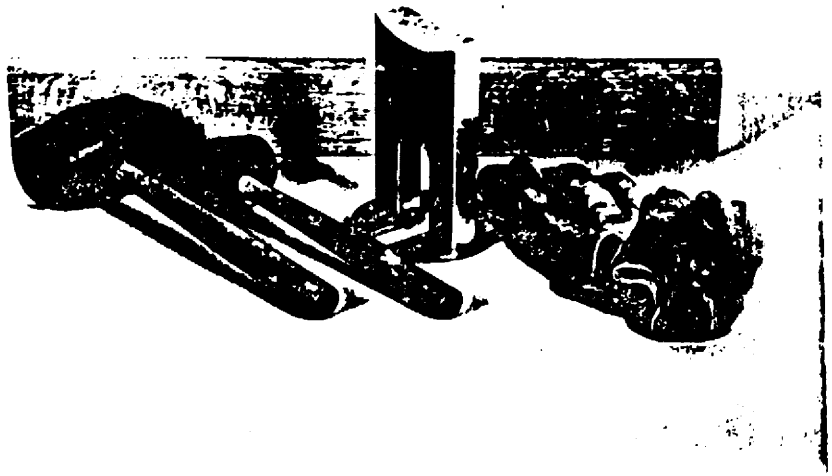
(P-3480)

REECo-36 (P-3534)



REECo-37 (P-3533)

REECo-39 (P-3524)



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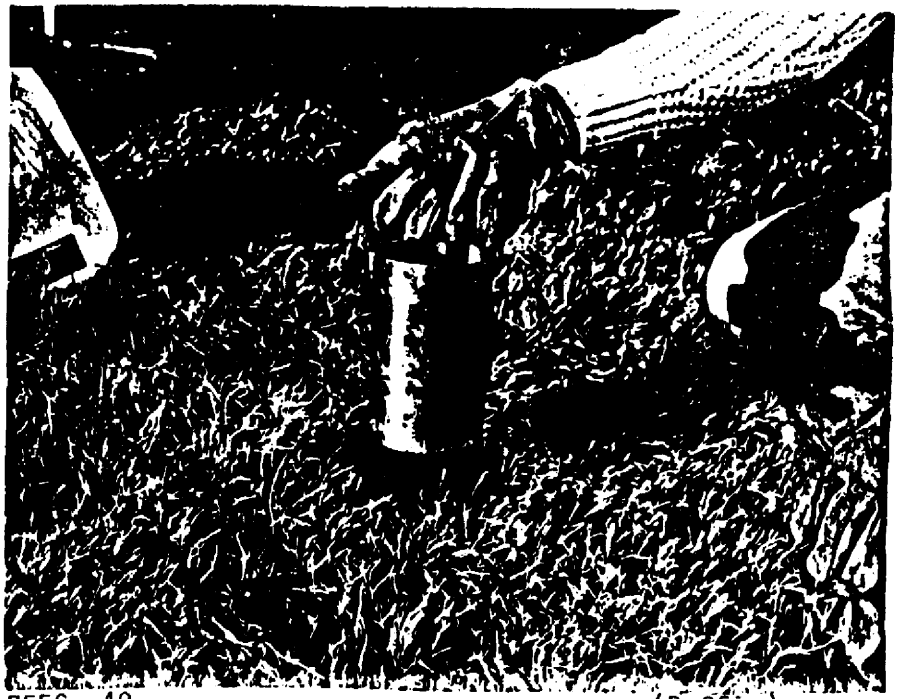

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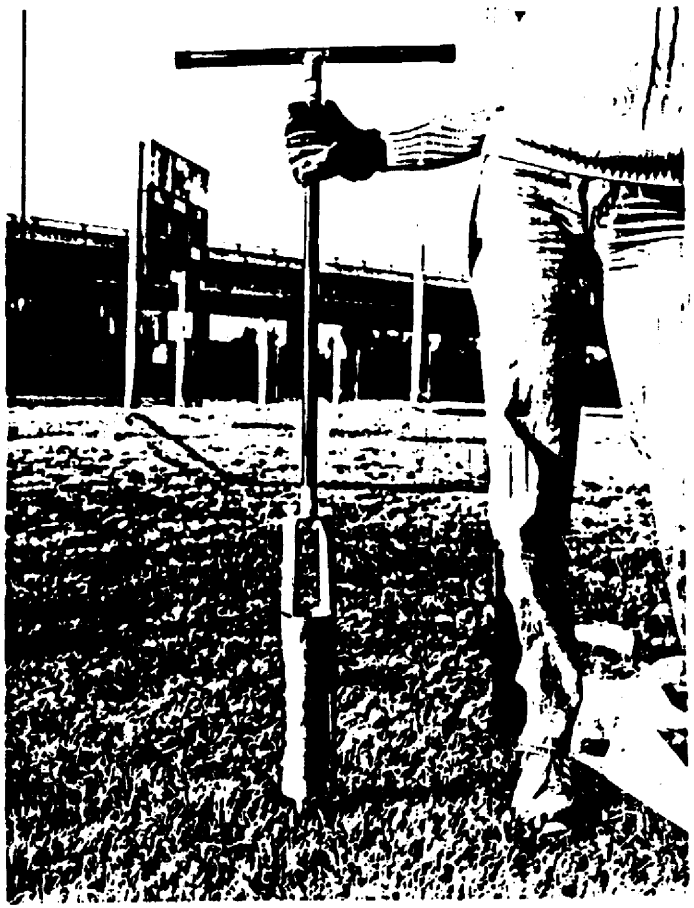

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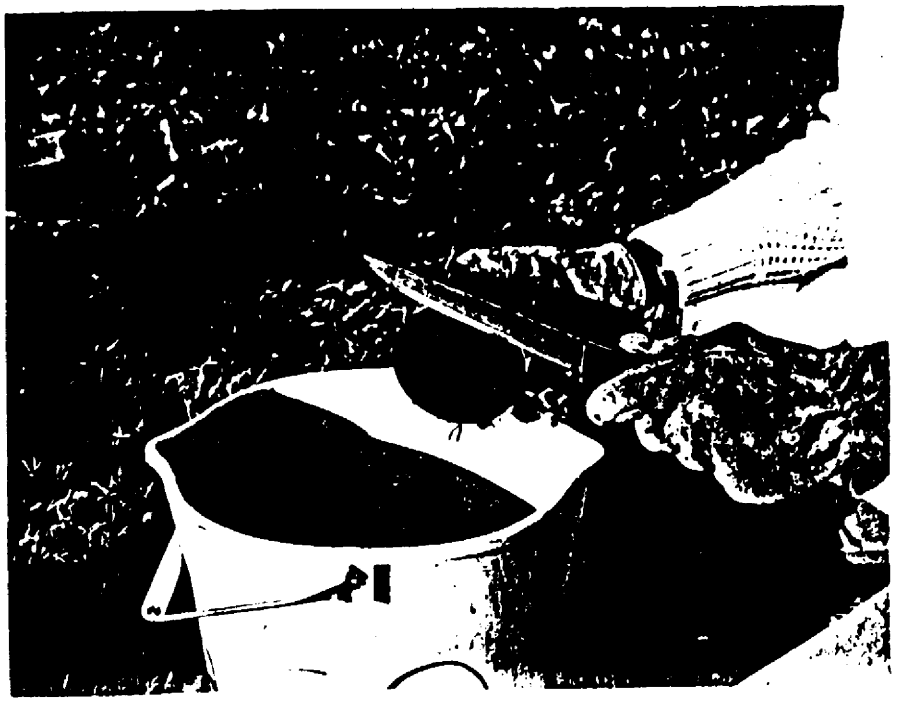

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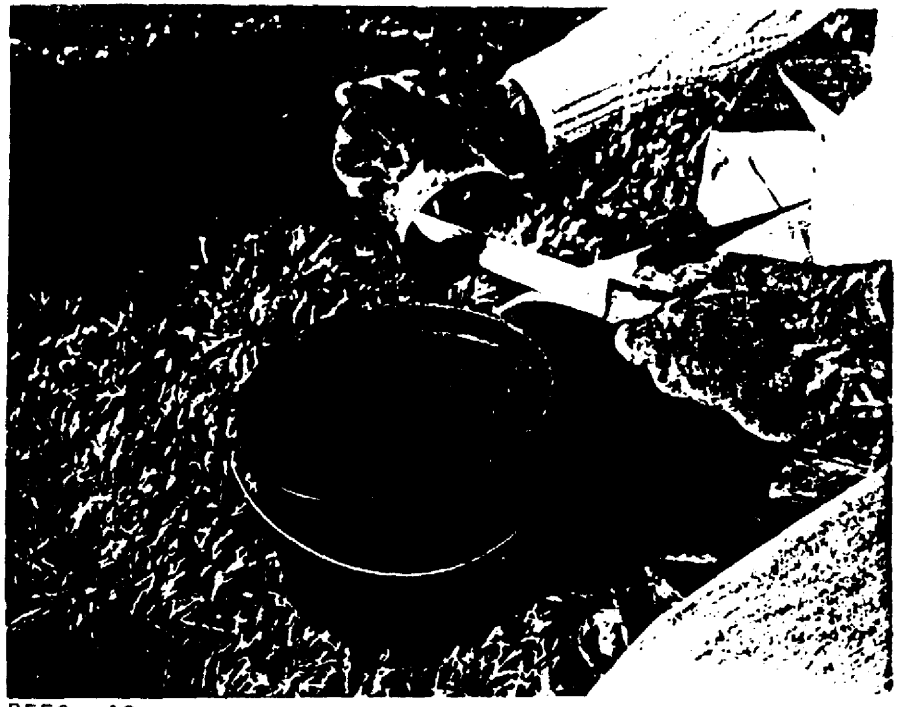

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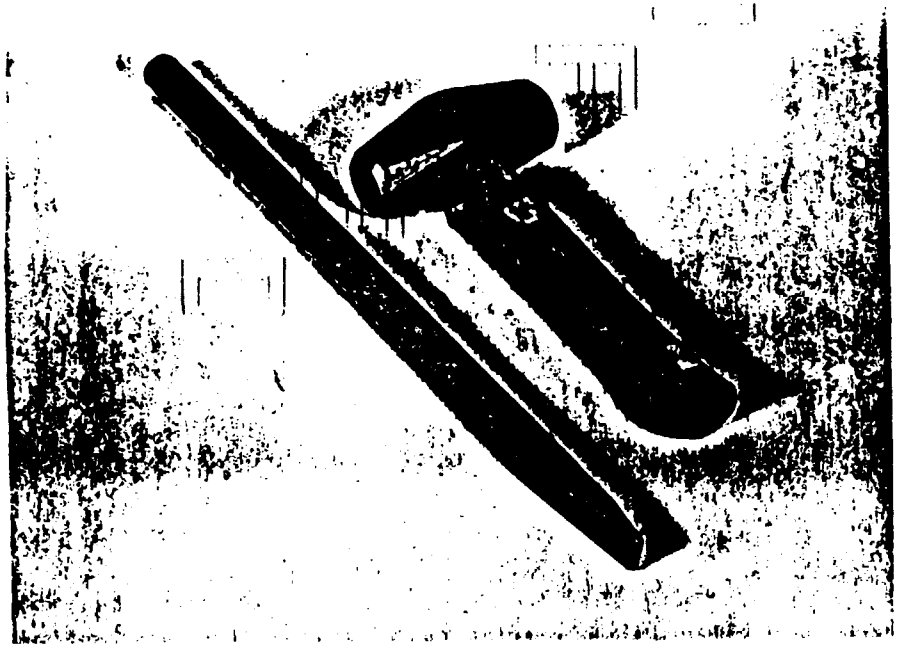
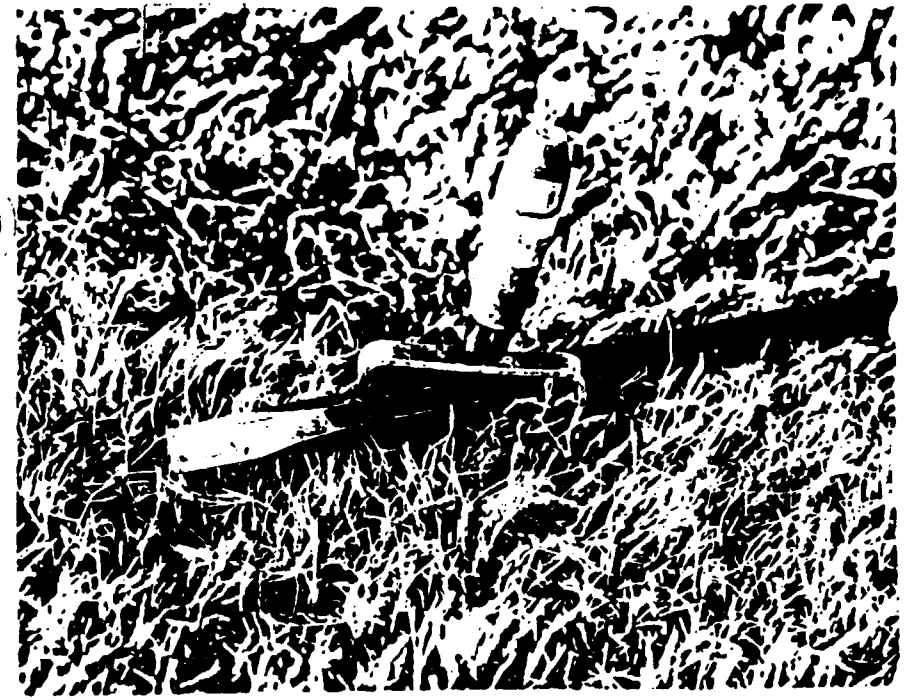
REECo-44 (P-3518)

REECo-45 (P-3515)

REECo-46 (P-3484)





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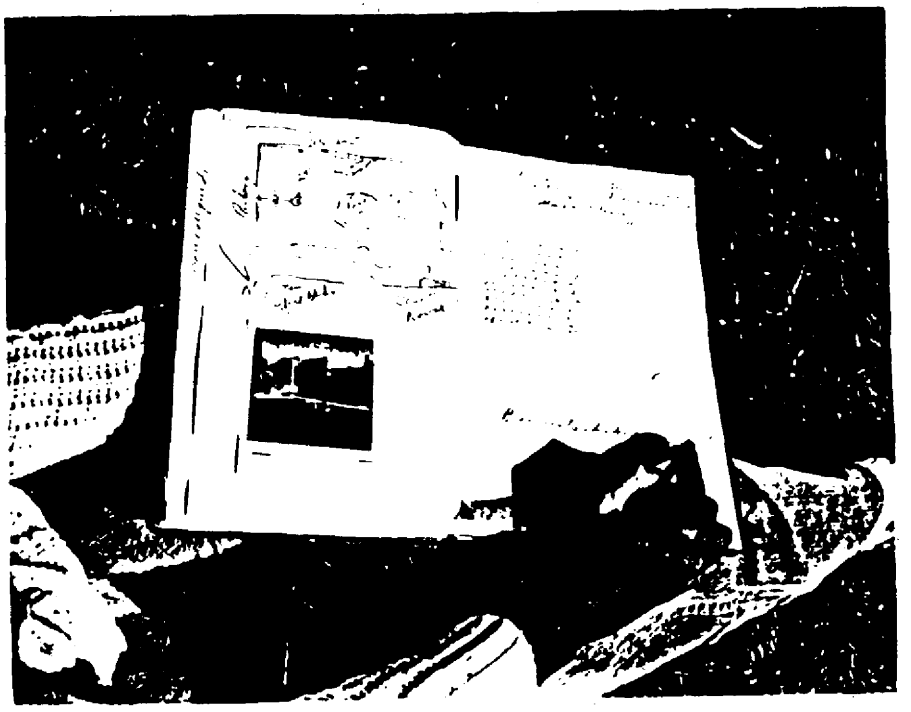
REECo-49 (P-3519)

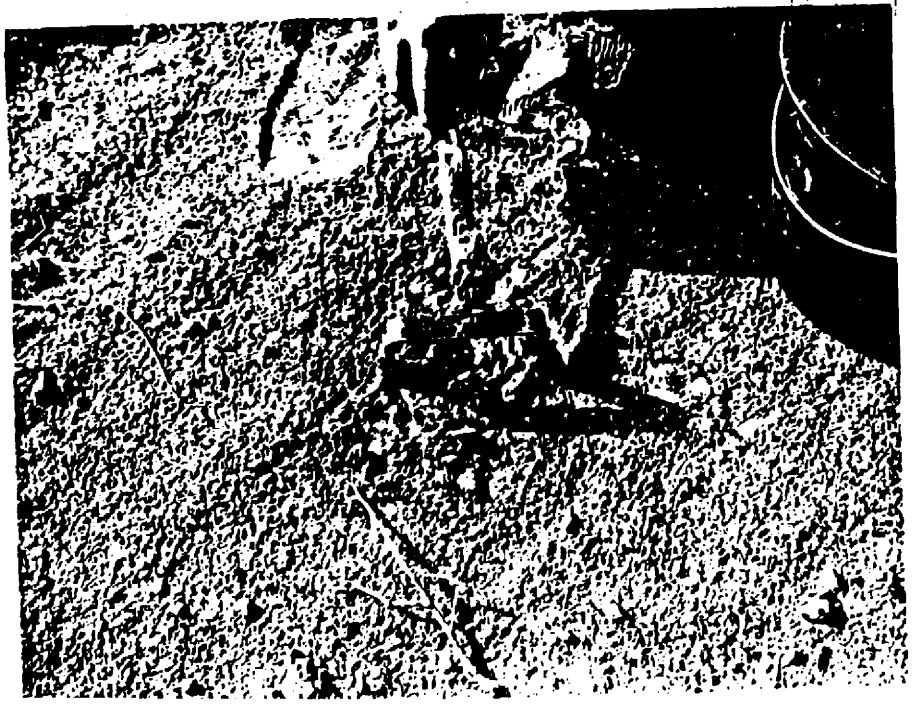


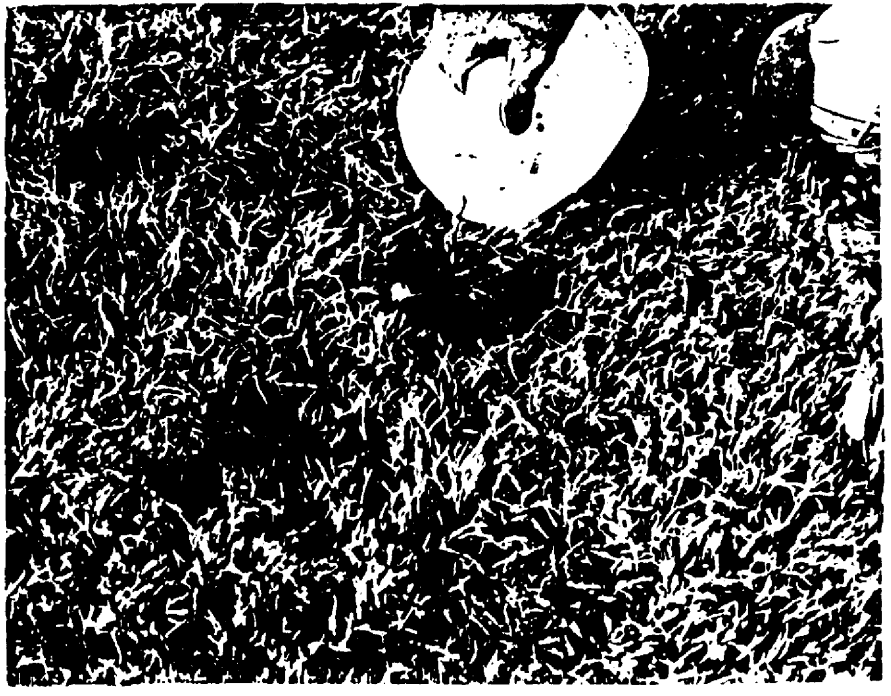
REECo-50 (P-3493)

REECo-51 (P-[illegible]02)

REECo-52 (P-3501)

REECo-54 (P-3520)





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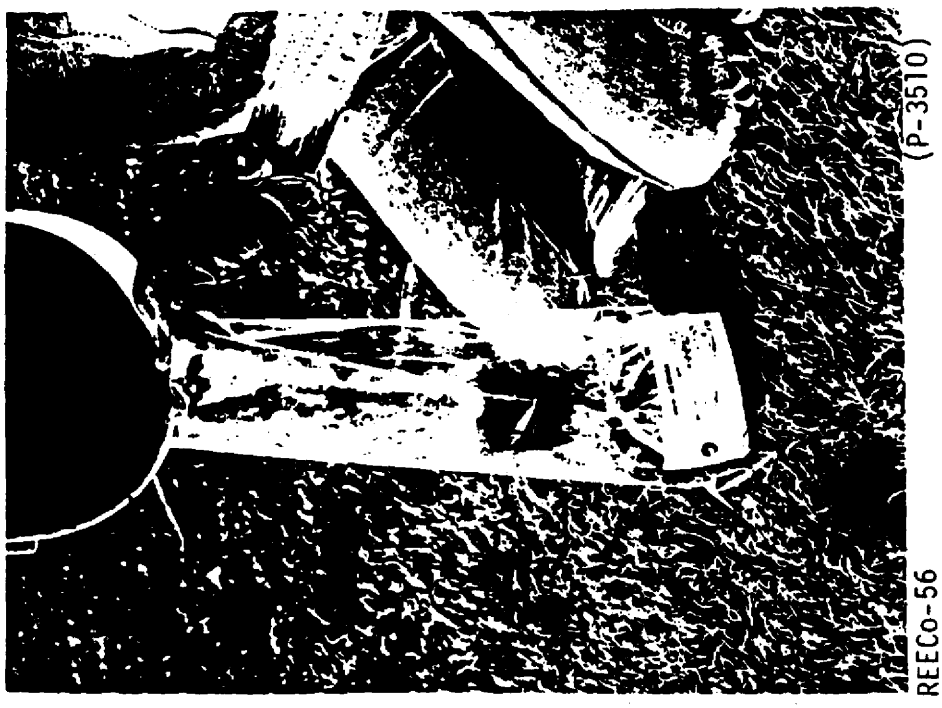

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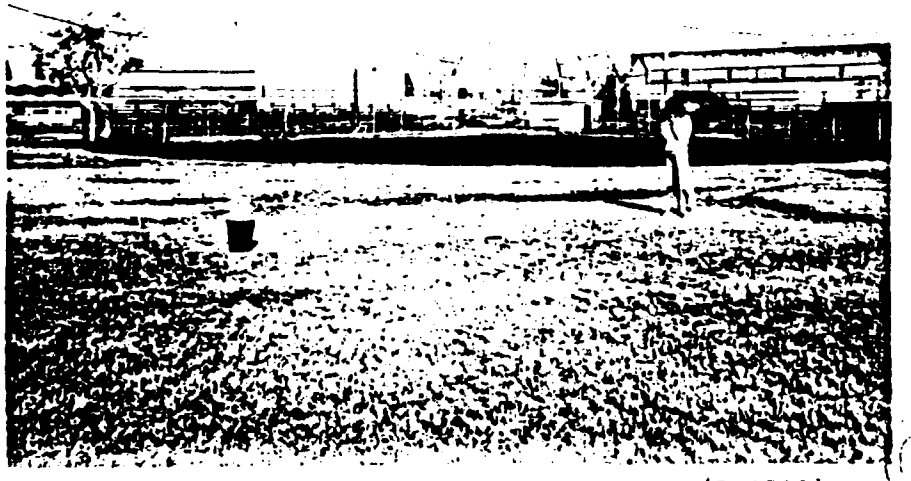
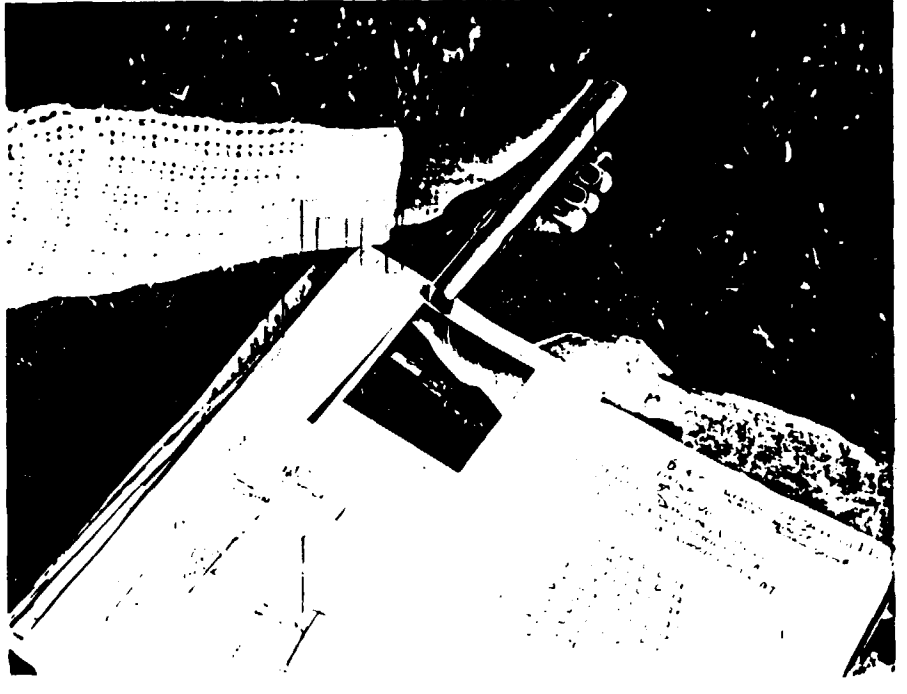
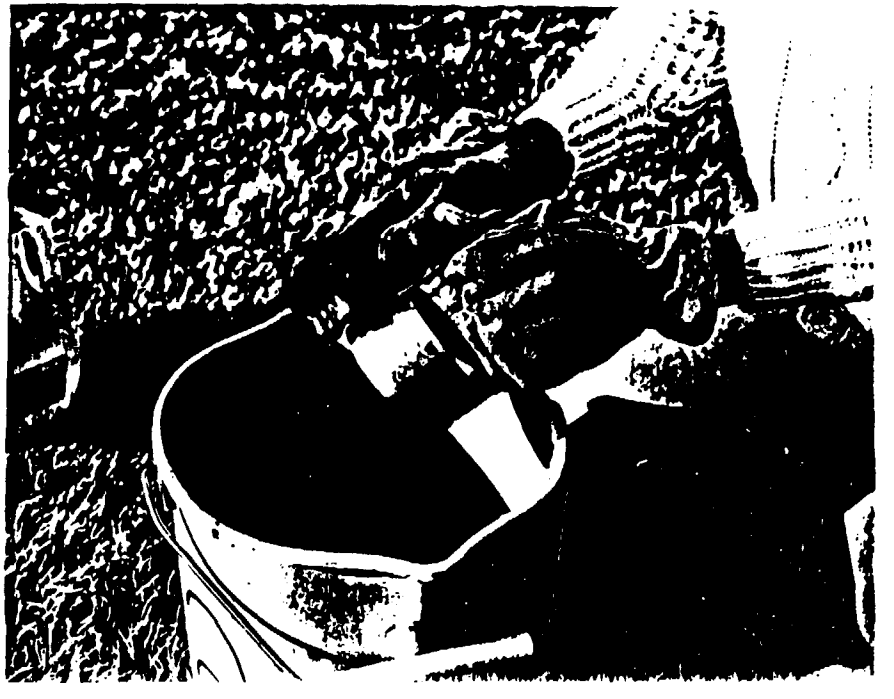


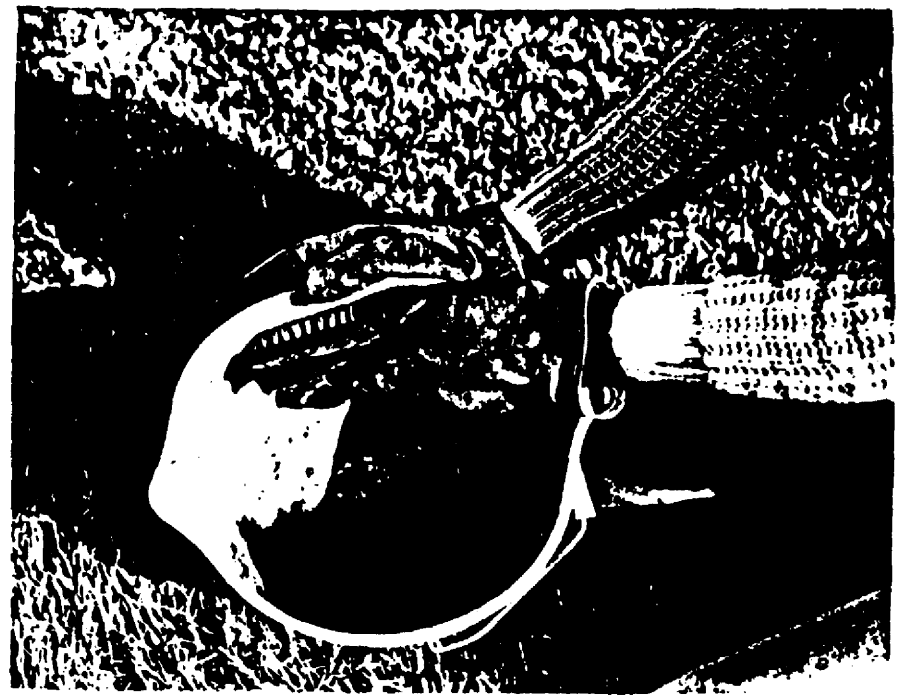
REECo-58 (P-3509)

REECo-60 (P-3504)





REECo-62 (P-3505)



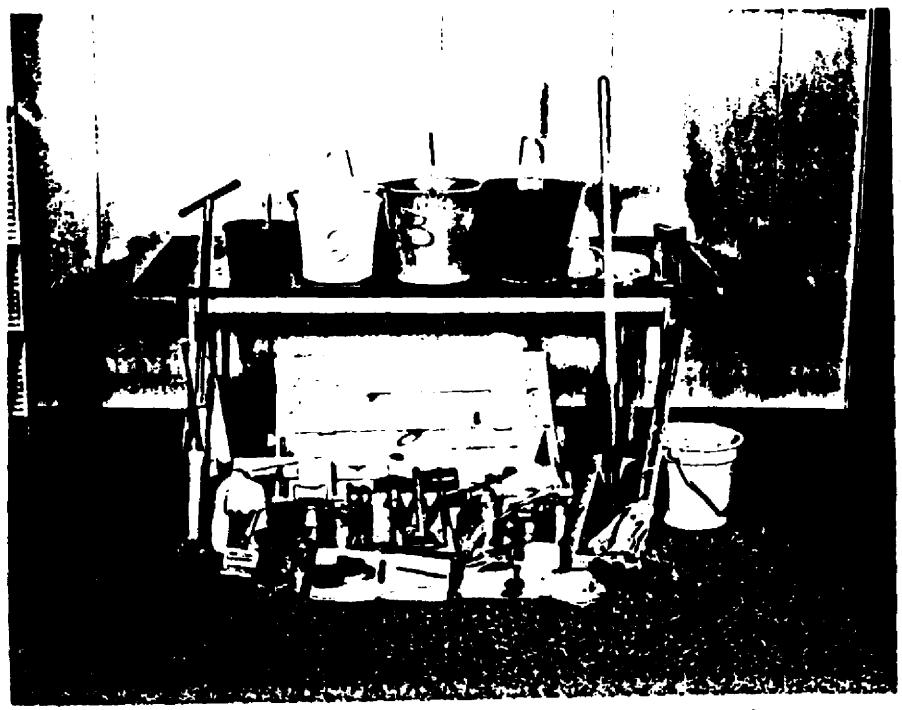
REECo-64 (P-3537)

REECo-3 (P-3486)

REECo-65 (P-3499)

REECo-66 (P-3498)

REECo-67 (P-3496)



REECo-68 (P-3472)

CHAIRMAN MOSELEY: Can we come back to order and resume. Could we continue with the presentation on the soil sampling.

DR. HAWTHORNE: This is a schematic (HH-1) of how the sample gets moved through the processing scheme in the laboratory.

The scheme is a hybrid. It is partly how EML recommends doing samples and it is partly how REECo did soil sample preparation for the NAEG program.

We wanted to take components of each methodology. We liked the REECo part where the grinding is carried out in a closed container so that there is no chance of cross contamination of either the laboratory or nearby specimens and there were particle size requirements that came from the way EML does their processing.

We were initially anticipating that we would not have to process the entire sample because in the fourth increment at those places where we have a 10-30 centimeter increment, the weight of the specimen can be up as high as 30 kilograms and that is a lot of material to put through a little round screen.

We believe we have successfully combined portions of each of the procedures into a system that can be effective both in the processing context and efficient in the manpower requirement. Could I have the other slide, please.

Again I have divided the different steps in the processing into smaller groups (REECo 30). These are the preparation before you begin doing the processing. The processing itself is called ball-milling, which will have an obvious derivation of name. Then we drop down to the exciting part which is removing the aliquots for radiochemistry which is what all of the activity is leading towards and, our final step is again probably the most important one, and that is cleaning up the equipment before you start

the next specimen.

We operate on the single specimen basis. DRI has skillfully removed the specimen identification from all of the samples that we are going to be doing immediately. They have prepared a group of 40. Instead of saying, "Telluride, Colorado; November 20 whatever, Maza and Rothermich, zero to two increments," we have a five-digit number which corresponds to the log number for the radiochemistry group (HH-2).

When it comes time, and I will be talking about making composites, we have to be notified by DRI which two specimens we put together to make the composite for the plutonium samples. If you would go back to 29 for a another look.

The sample leaves the field in a canvas bag. There are four increments in the canvas bag, with a shipping tag on the outside. We receive those in the laboratory, open the bag, and take out a specimen and weigh it (REECo 69). Now that will no longer be happening because DRI has already removed the bags for the specimens processed under Phase II of the ORERP program. We have a large plastic bag (REECo 70) which we use as a pseudo glove box. We had lots of experience in cleaning up before we went to the procedure that will be shown. Specimens are wiped off and that will still hold in the future (REECo 71). The moisture in it is kneaded because there is condensation on the plastic. We want the moisture to be in the soil when the bag is emptied. We don't want little globs of wet soil sticking to the inside of the bag.

The specimen bag is inverted. It will remain inside the larger bag until the gallon cans, which you can see through the bag, have been filled and all of the specimen is transferred into gallon cans for drying (REECo 72). The easiest way to open the bag with the least trauma has turned out to be to cut the bottom off. That leaves the tag attached. We

know where the stone and the pieces of root belong when we come back to get a tare weight for the nonspecimen soil.

Vegetation is cut into quarter-inch increments (REECo 73). We found it turns out to be much quicker than to leave the grass long because then we don't end up with a sieve covered with grass. The grass does grind and goes through the sieve. There is a mandatory requirement to wear rubber gloves for almost all of the processing steps. We use a steel brush (REECo 74) to dislodge soil from stones that are large enough to pick up. We went to a steel brush because we can clean it effectively in a sonic cleaner. Cleanup is a critical step in the whole procedure.

We transfer the soil into the cans (REECo 75) and clean them off as they leave the pseudo glove box (REECo 76). They are dried 24 hours at 105°C (REECo 77). While the drying is going on other activities take place in the processing. We go back and we get into the data collection. We took a wet weight of the entire specimen as it came from the shipping bag. We also weigh the bag itself, the tape, the tag that's inside, the stones and the roots to get a tare weight for the wet weight (REECo 78) from the field specimen.

After the sample has been dried, we get into the processing proper. Grinding is done by steel balls, rotating inside of a can that is turning at between 130-140 rpm. We use 10 balls for a 2,000-gram specimen (REECo 79) because that works the best or has with us. In passing I might note that all of the information that we have about the specimen goes onto the metal can as well as into the record books.

The ball mill is a series of rollers (REECo 80). Each section, if you wish, will grind 10 one-gallon cans. They grind initially as shown on Figure 29 for three hours. We then sieve them, grind the coarse material for an hour, sieve again, regrind the remaining coarse material and sieve

off the fine fractions on each of those grindings. We do the sieving because the fine fraction tends to cushion the oversize material that we are trying to abrade.

We had an interesting occurrence in that every time we pried up the lid of the can there was a puff of what looked like smoke. We went to all kinds of extremes to avoid that. We cleaned up rather frequently for awhile. We finally avoided that and a related problem ended by simply puncturing the bottom of the can, that vents the air that's been heated up by the ball-milling process, and we continue by cutting out the entire bottom of the can (REECo 81). That does away with stone lodging in the rim of the can and it also makes the transfer of the material out of the can a lot easier because you are pouring it across a smooth surface instead of across a rim.

The steel balls are retrieved after the grinding session (REECo 82), and we now come to the part which is an absolute art, and that is, turning the can upside down, onto the sieve (REECo 83), without making dust or spilling it or dropping the whole thing. Richard Grisham in the back and Eddie Eubank have developed this talent to a high degree.

For those of you who have not seen a soil sieve (REECo 84), the set consists of a metal pan in which the "less-than" fraction is collected, the brass screen, which does the separating, and the metal cover which keeps us from contaminating the rest of the laboratory. The three parts are taped together as shown in the previous slide, and the separating is done on the vibratory shaker (REECo 85). This, also, is an art. The time to reach separation is a function of the characteristics of the soil that is on the screen. You cannot say that you will sieve for ten minutes at a setting of 20 or you'll sieve for six hours at a setting of 75. It has been found much more successful if you listen to the vibrator and the screen will tell

you, by its sound, when there is no more material leaving on the separation operation.

We send the coarse fraction right off to storage (REECo 86) as indicated on the flow diagram at the end of the three ball-millings. We consolidate the less than five hundred micron fraction into as few cans as we can comfortably homogenize. The homogenizing is done by ball-milling the can that has its maximum content a few minutes until we get homogenization.

At the present time we are adding five hundred milliliters of soil to the counting bottle. The bottles go to the Test Site and are put on a automatic sample changer (REECo 87). In the rubber glove is a vibratory spatula which has been one of the most useful tools for transferring materials and for cleaning up screens and doing various odd jobs.

We make up a 200-gram composite soil specimen for the leaching process in radiochemistry and I have already indicated that we need the collaboration of DRI in getting the proper specimens combined. At this point we have accomplished what the collecting and processing set out to do. For us, we still have an important ways to go and that is cleaning up all of the hand tools, the screens, the pans and covers that we have contaminated with dust along the way. If you come into the lab and watch the processing as it goes on, you'll notice that you don't see dust coming from the operations. We have been very concerned about eliminating dust from our operation. When we started out we would wash all of the equipment with detergent in the sink, then dry it, and found that we could draw our initials or pictures of our family on the surface of the pan for the screen. It didn't really matter how much brushing we did or how long we did it, we still ended up with a film (REECo 88). We went to the sonic cleaner and no longer have film on our equipment.

The equipment comes from the sonic cleaner, gets a water rinse, goes

into the drying oven and is taken out and put into trays. We keep trays marked "clean" and "dirty" so we don't get into the wrong one when we do another operation. The sieves are cleaned with wire brushes and compressed air.

If you will go back to the viewgraph flow chart (HH-2), I'll go through it as my summary.

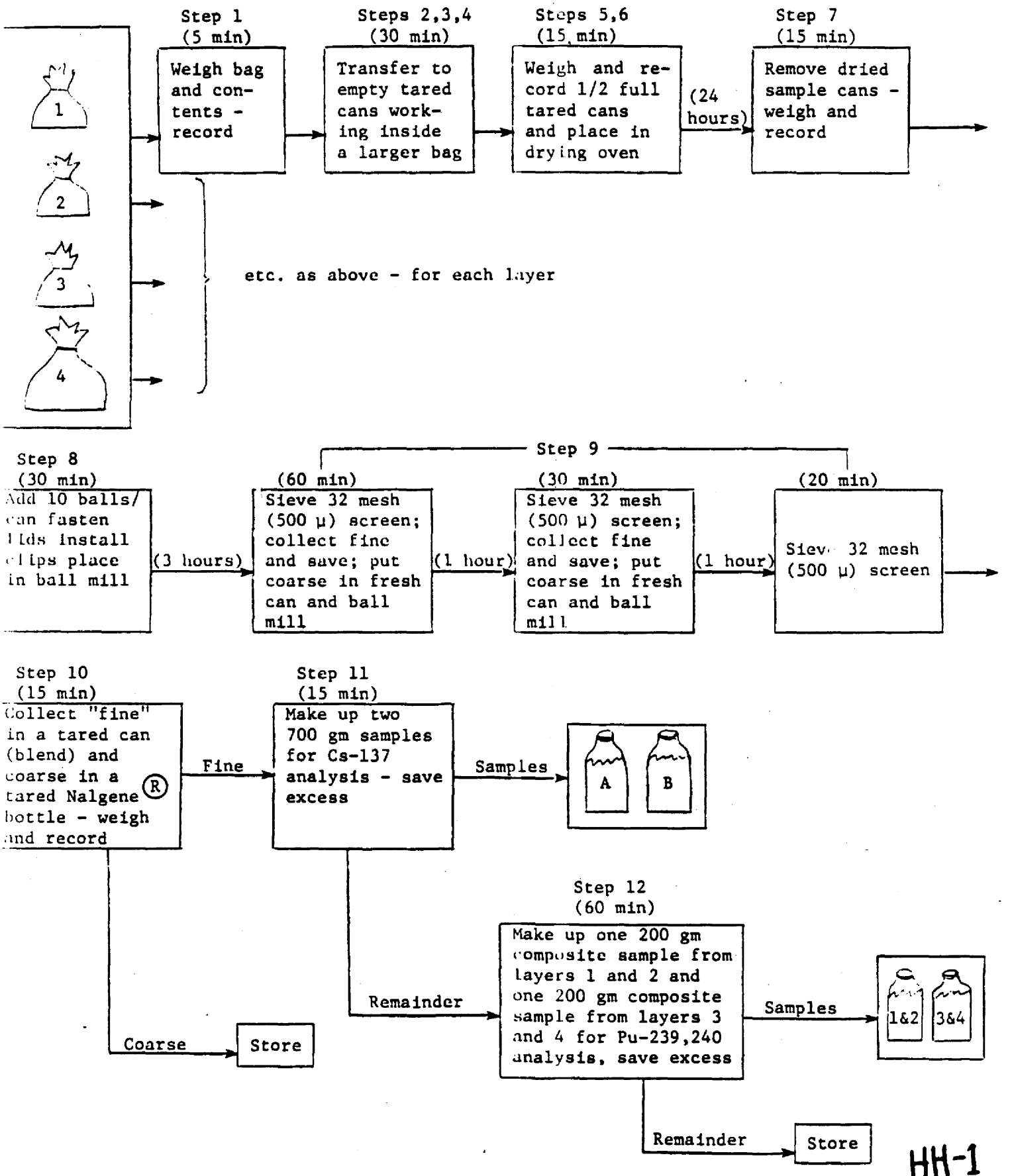
We obtain the wet weight of the specimen that has come in from the field. We cut up the vegetation. We remove the rock and the large roots. We transfer the remaining material to drying cans. The specimens are dried 24 hours at 105°C. They come out of the ovens, are weighed. I have not shown pictures of weighing on the scales. There are a number of those operations. We add the grinding balls. Put the specimen onto the ball mill for three hours, separate the less than five hundred micron material on the screen. Send the coarse material back into ball-milling for another hour. Sieve again. Ball mill for an hour. Make our final sieving. All of the fine materials have been added together from those three grindings. The coarse material goes off to storage. The fine material is composited, mixed, and we will start weighing out the specimens for radiochemistry. In the procedure, if we have the material, we will weigh out two specimens for cesium-137. One goes to radiochemistry, and one we keep in storage. Sooner or later there are going to be those calls for duplicates and we prefer not to have to go searching for the duplicate in storage.

We make up, and I show a dotted line because it's not a procedure that we perform at the time that we do the weighing out for the cesium, and make up a 200-gram composite sample from two specimens which represent increments one and two or increments three and four from the initial profile. The remaining fine material goes to storage. Again, if we have the material, we make up two of the plutonium composites.

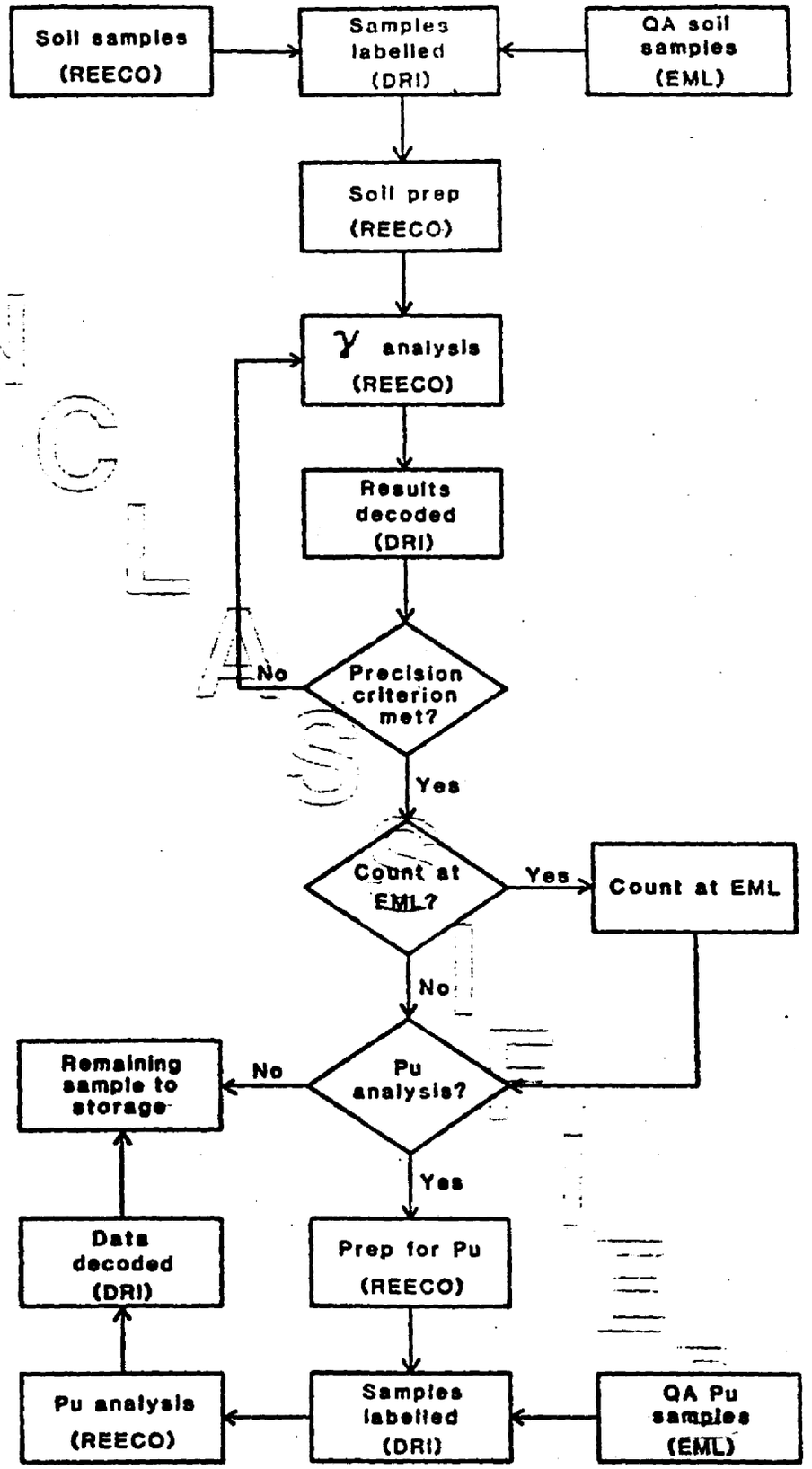
That concludes my presentation. Are there questions?

CHAIRMAN MOSELEY: Questions? Thank you very much.

PROPOSED SOIL PREP - FLOW CHART



HH-1


Soil samples (REECO)
Samples labelled (DRI)
QA soil samples (EML)
Soil prep (REECO)
γ analysis (REECO)
Results decoded (DRI)
Precision criterion met?
No
Yes
Count at EML?
Yes
Count at EML
No
Pu analysis?
No
Remaining sample to storage
Yes
Prep for Pu (REECO)
Samples labelled (DRI)
QA Pu samples (EML)
Pu analysis (REECO)
Data decoded (DRI)

HH-2

PREPARATION FOR PROCESSING

- Knead condensed water vapor into specimen.
- Weigh and record gross wet weight.
- Wipe bag and discard towel.
- Open specimen bag into pseudo-glove box.
  - cut vegetation into 1/4 inch lengths.
  - remove stones and wire brush rock.
  - remove large plant root fragments and wire brush.
- Transfer 2 kg of soil into each tared, labeled, can.
- Weigh cans and record gross wet weight.
- Dry cans 24 hours in oven at 105°C.
- Weigh cans of dry soil and record dry weights.
- Collect bag, labels, tape, stone, and roots.
- Tare weigh shipping bag and discarded elements.

PROCESSING SOIL

- Ball mill cans 3 hours at 130-140 rpm.
- Prepare hood and assemble hand tools.
- Transfer ground soil to 32 mesh sieves.
- Remove <500 μ fraction by sieving and hold.
- Ball mill >500 μ fraction 60 minutes.
- Remove <500 μ fraction and add to holding cans.
- Ball mill >500 μ fraction 60 minutes then resieve.
- Store >500 μ fraction.
- Ball mill composite <500 μ fraction a few minutes to homogenize.

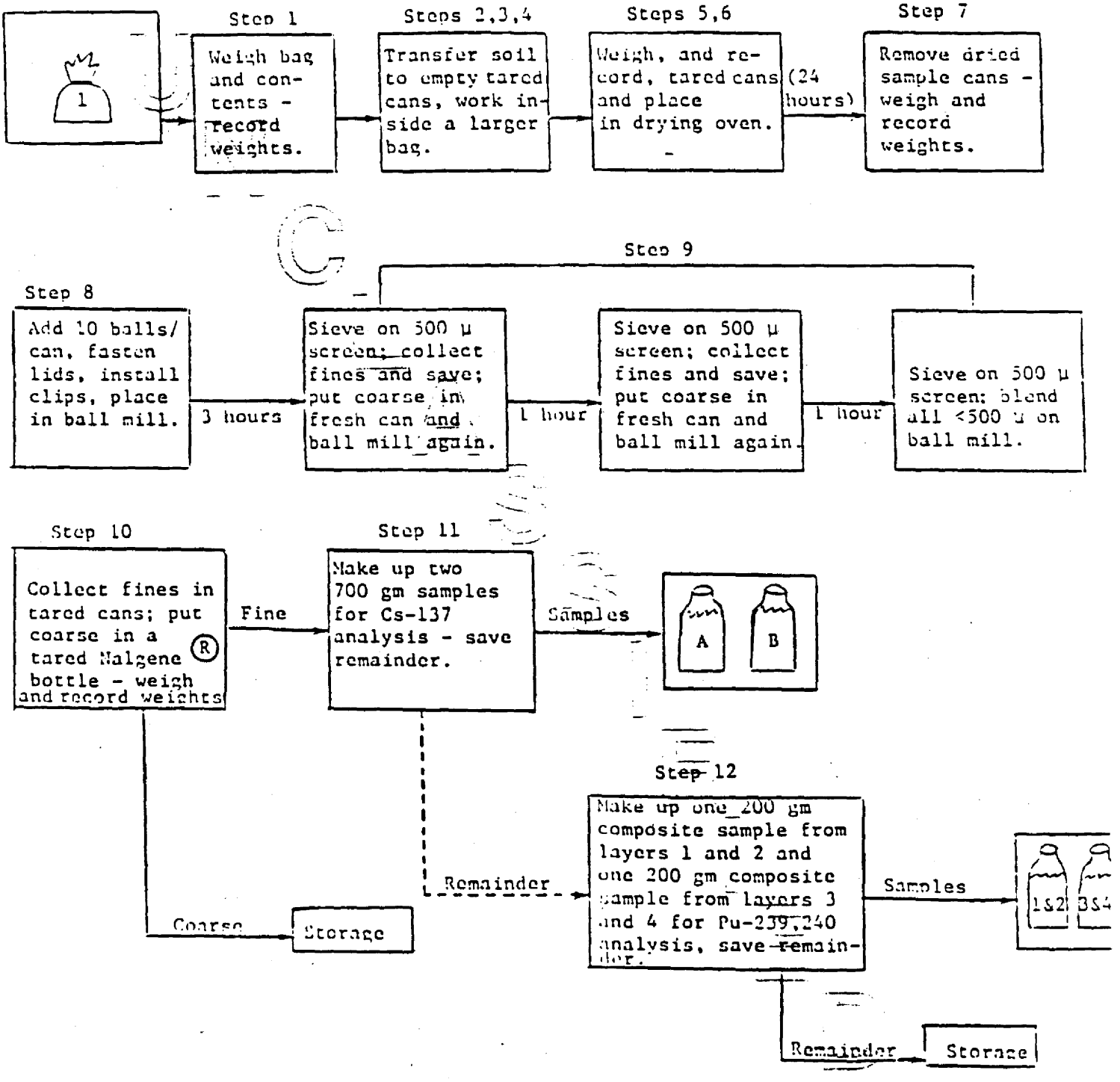
RADIOCHEMICAL SPECIMENS

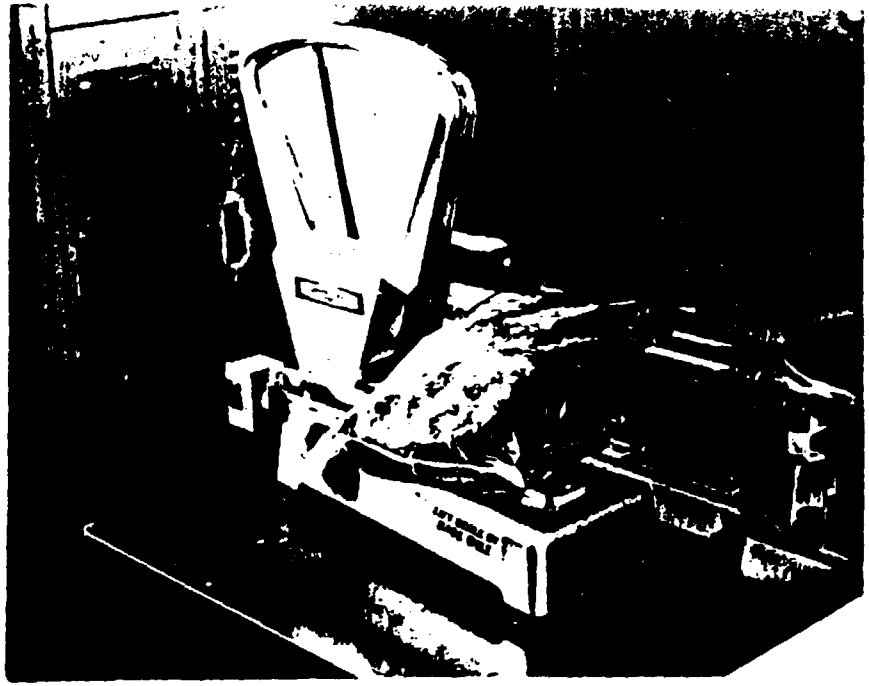
- Weigh out 500 ml of homogenized soil, twice.
- Use combined weights of specimens designated by DRI and prepare 200-gram composites, two.

CLEAN UP

- Clean all wire sieves with wire brushes and compressed air.
- Wash all sieves and hand tools in sonic cleaner.
- Rinse sonic-cleaned equipment in clear water and drain.
- Dry all washed equipment at 105°C.
- Discard hood liners and vacuum out the hoods.
- Wipe hoods and other surfaces down with cloth, including vibrating spatula handles.

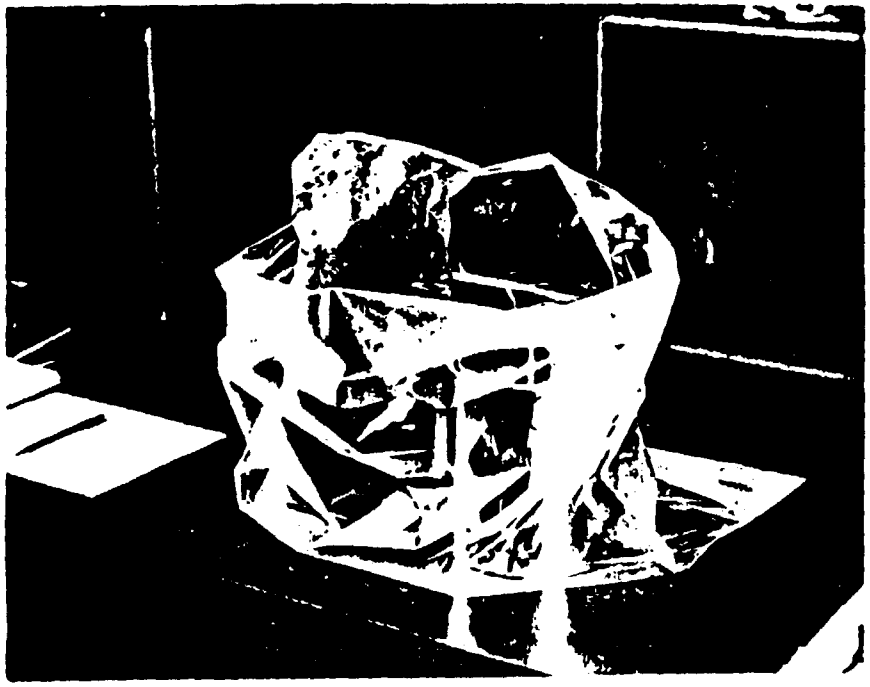
PROPOSED SOIL PREPARATION BY BALL MILLING





REECo 69 P 3452

REECo 71 P 375



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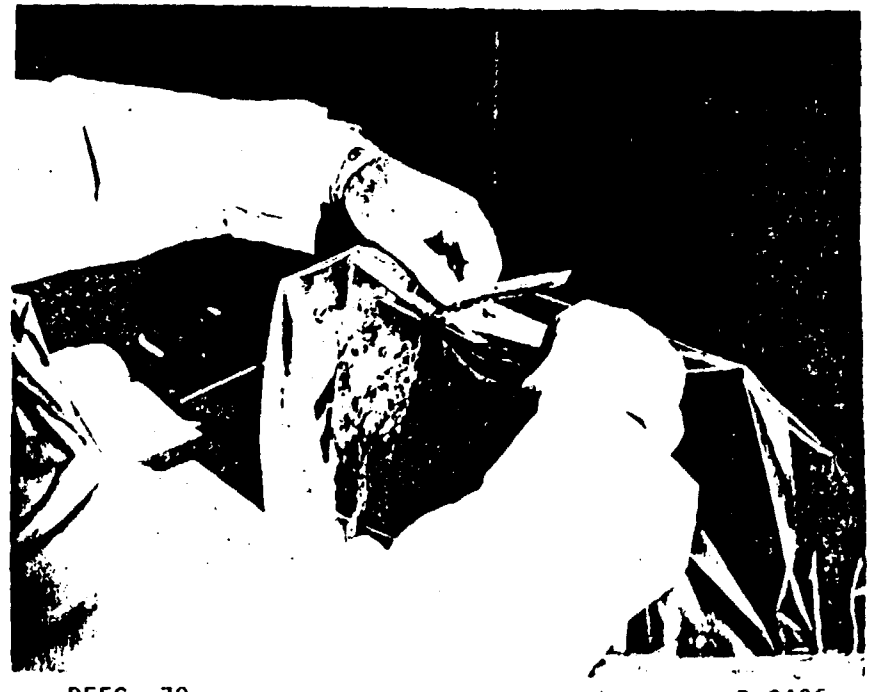

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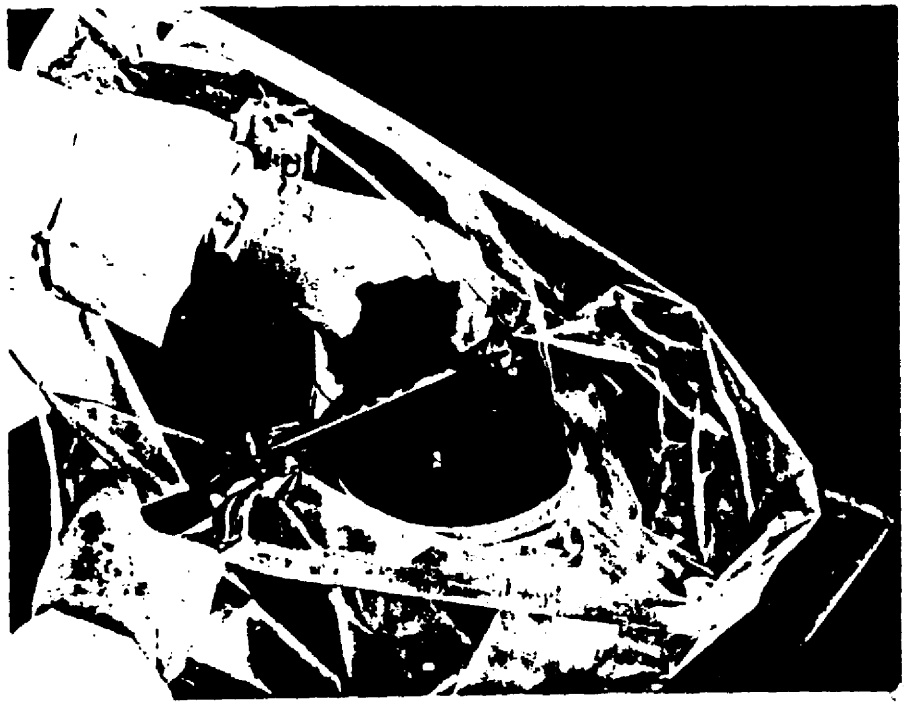

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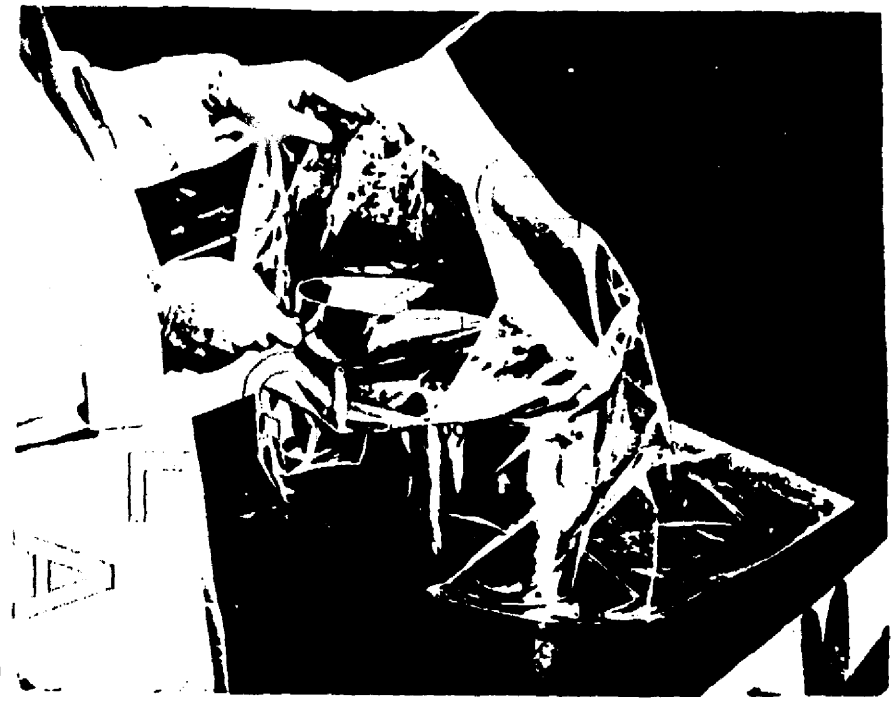

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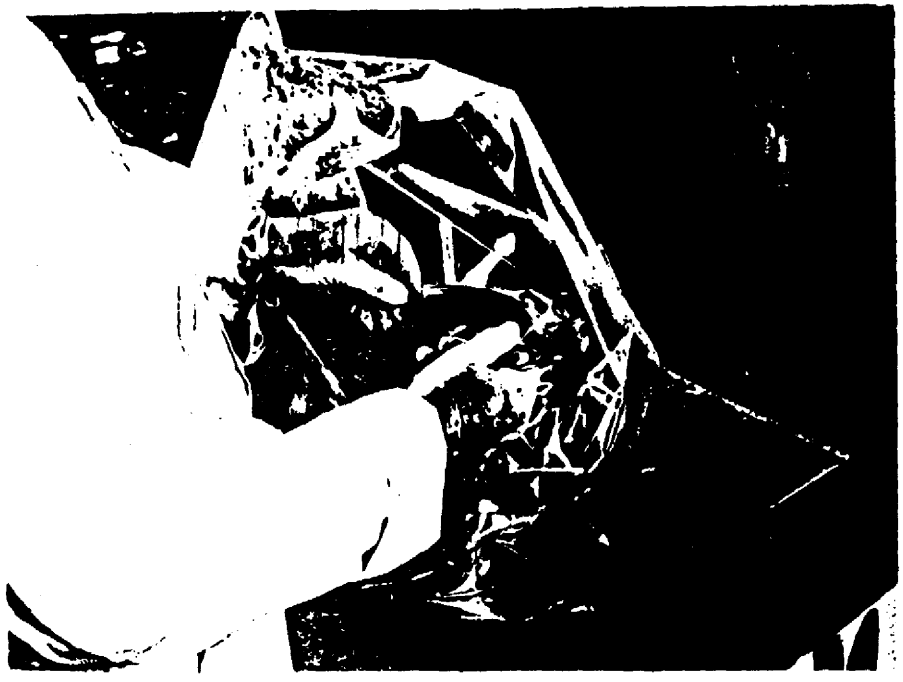

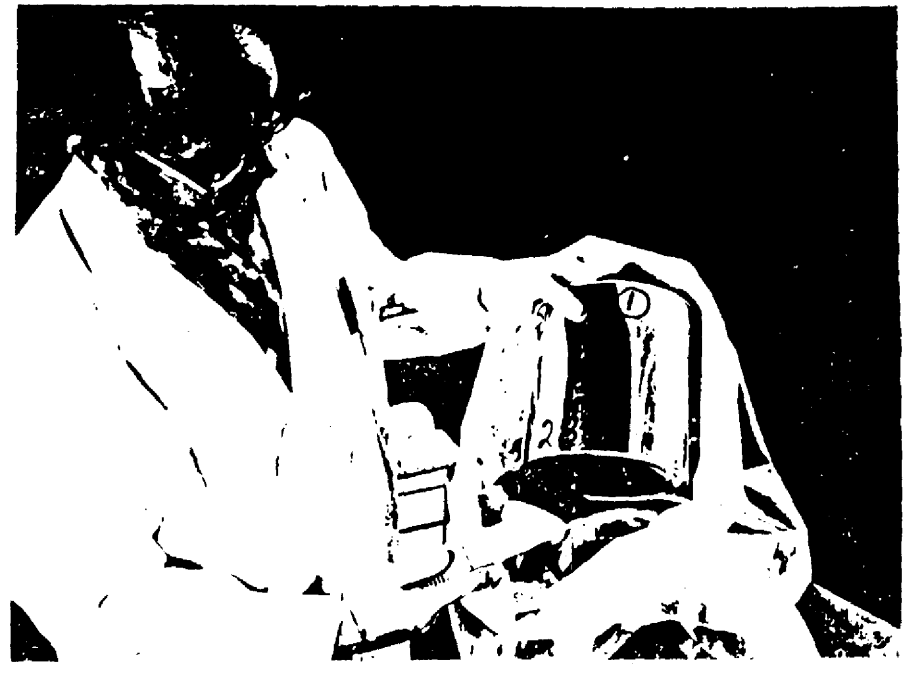

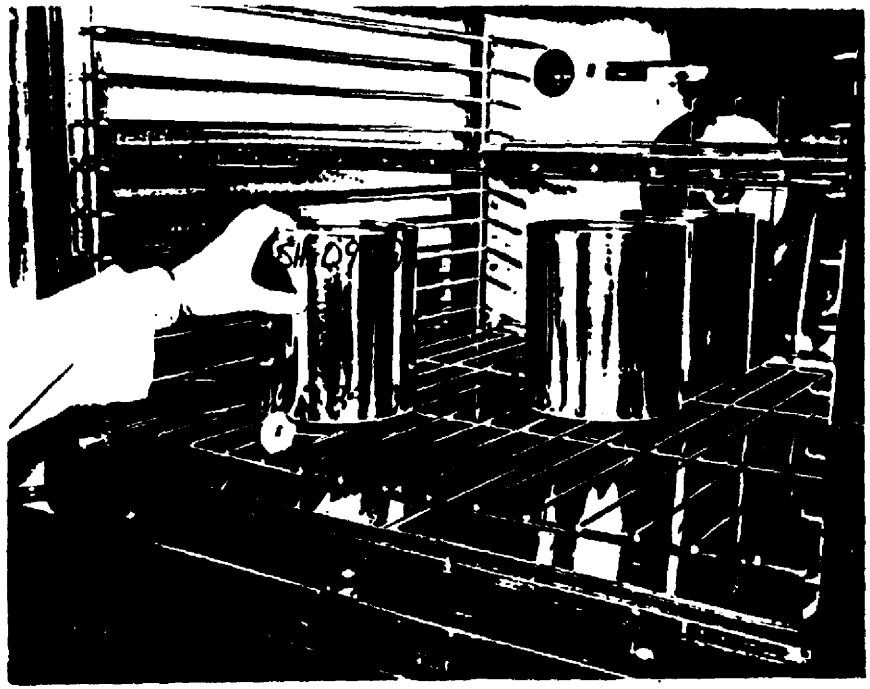

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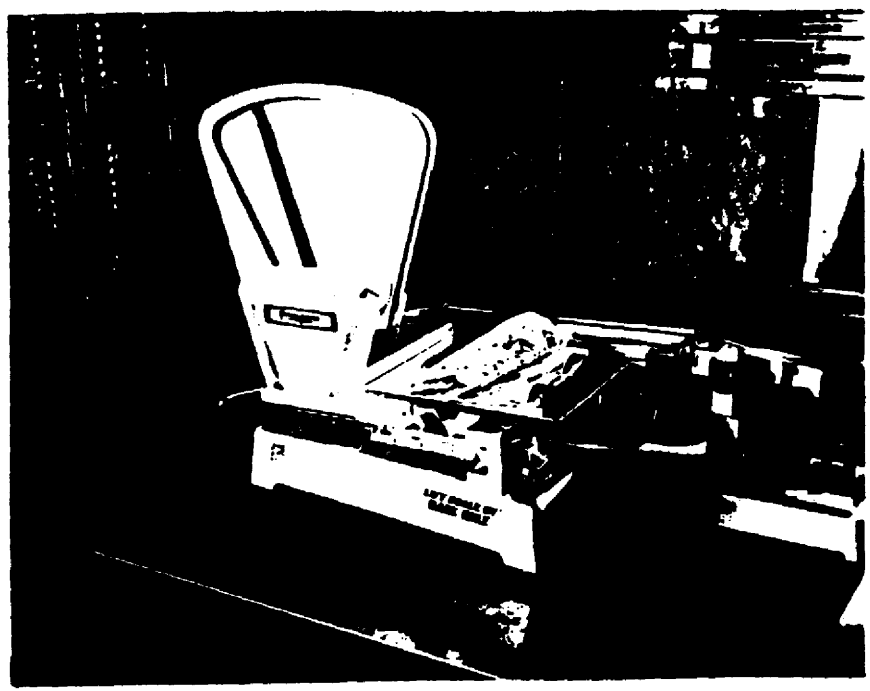

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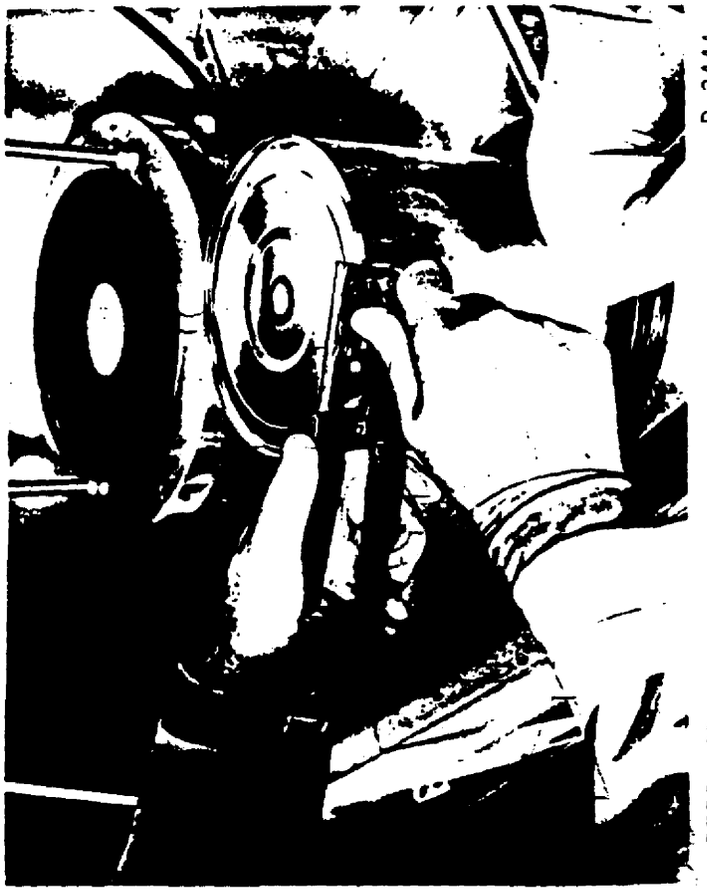

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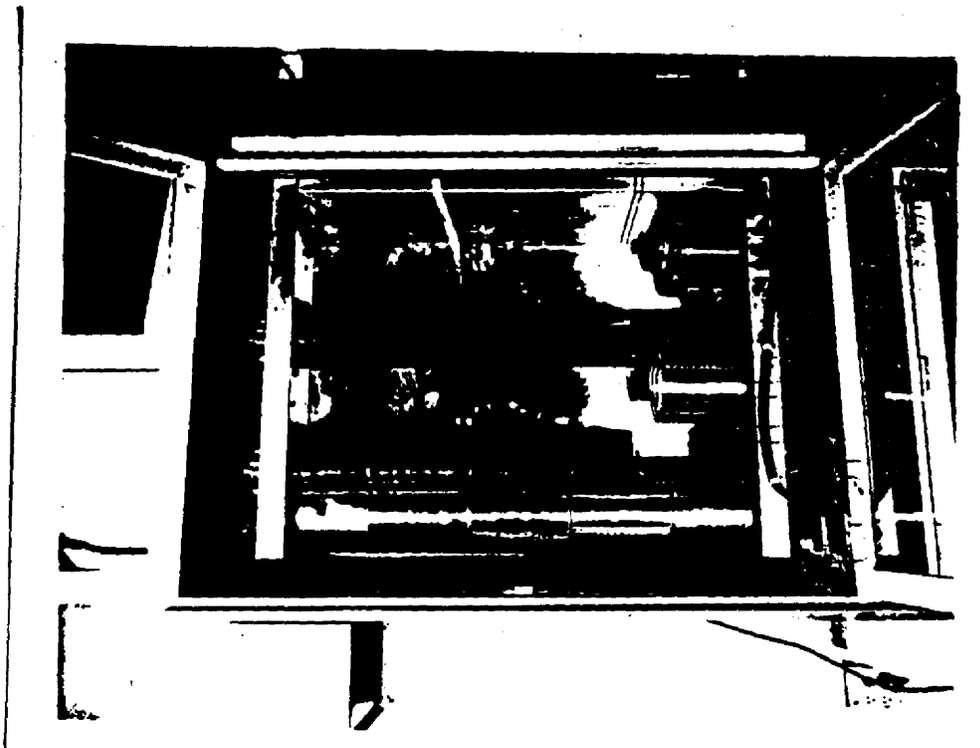

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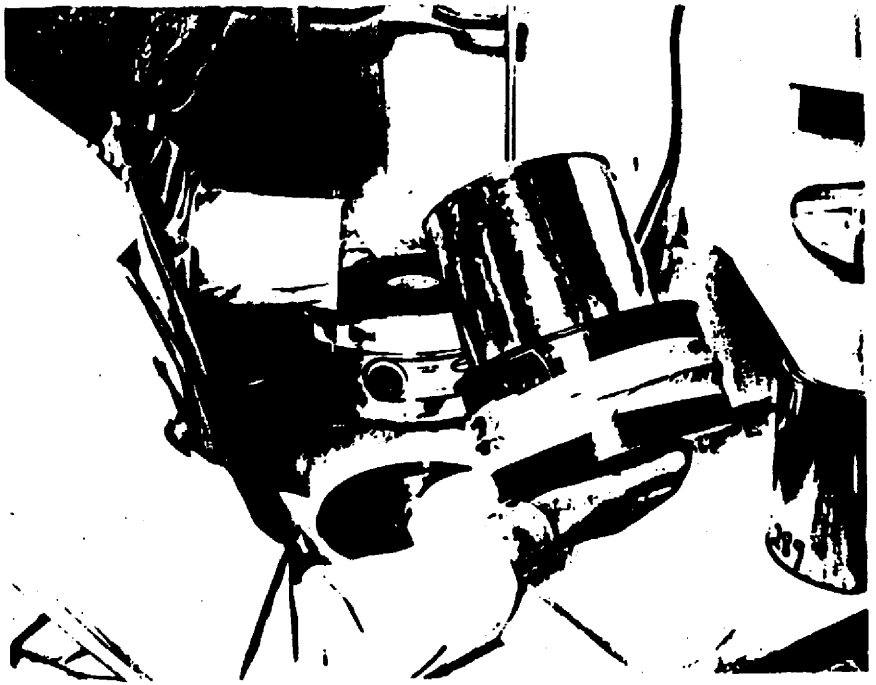

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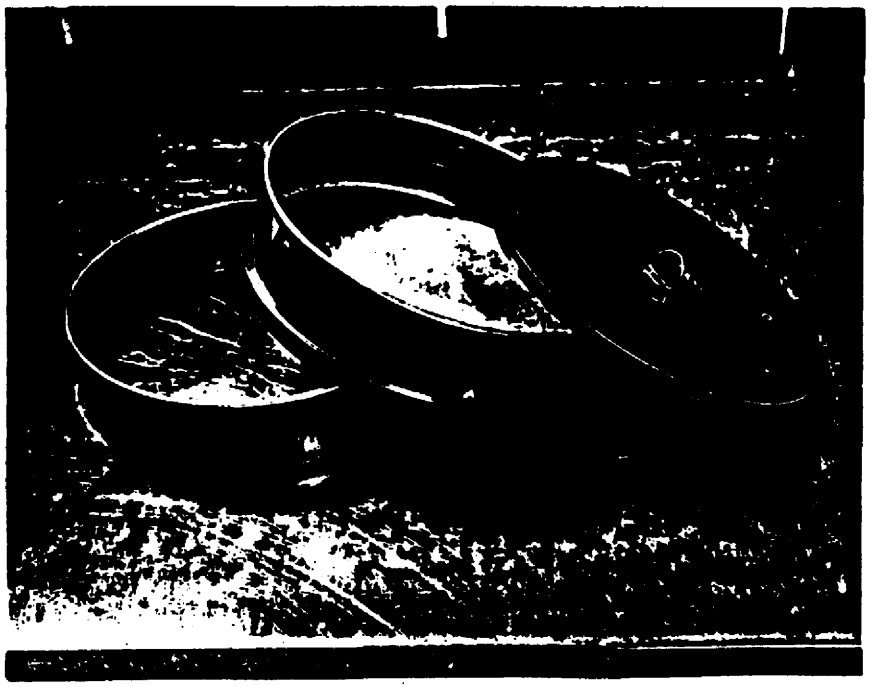

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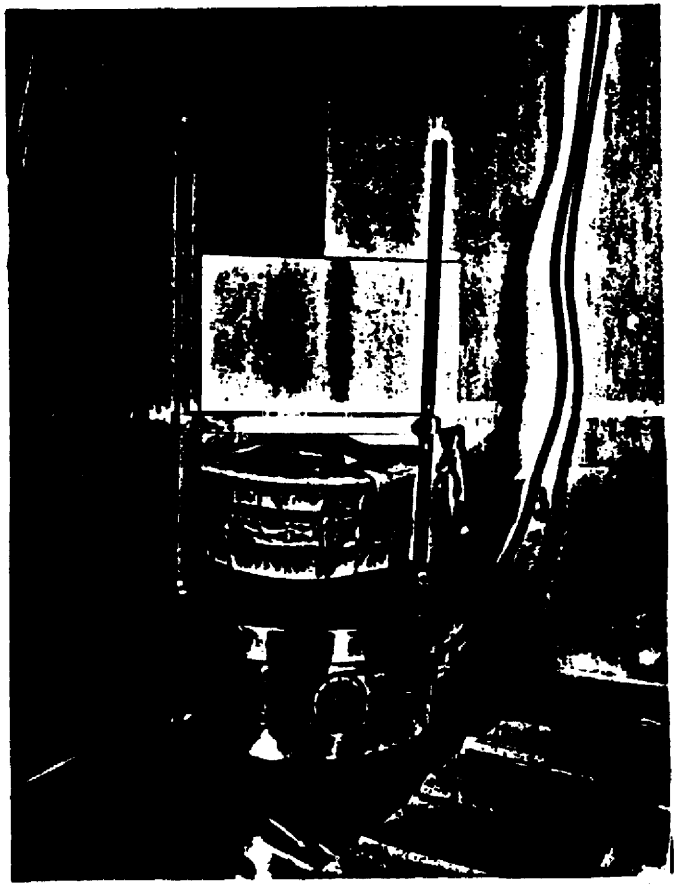

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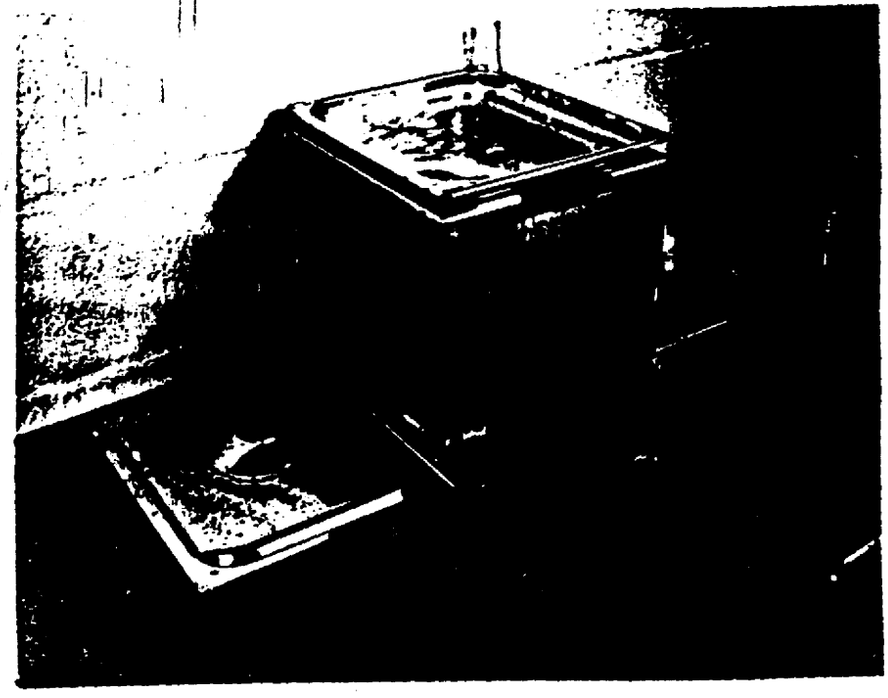

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CHAIRMAN MOSELEY: The next presentation is by Roger Thompson on the Review of the Laboratory Procedures for Soil Analysis.

DR. THOMPSON: I would like to talk to you today about the sample pathways in the laboratory with some of the aspects that have an impact at each step.

Now, the top box (31) is essentially what Howard has just talked about. The soils lab has received the sample, has ground it, dried it, and they have loaded it into a five hundred milliliter bottle, and DRI comes in and takes away all of the information about the sample location, and he has assigned a five-digit number. We have given them a block of laboratory numbers. DRI will paste labels on the bottles which have only this number on it so that the laboratory has no knowledge of the depth segment that it comes from or the location. Along with the bottle there is some paperwork that's filled out that says what type of analysis is needed whether it's cesium-137 or plutonium.

For the cesium-137, the bottles are completely full. Howard mentioned that he fills it with 700 grams. It depends a little bit on the density. He fills it to the shoulder of the bottle and it will be more or less, depending on how much material is in there.

Consider the leftmost branch. The bottle comes down and the paperwork, and we log it in the laboratory, and then, depending upon the type of analysis, it goes to the left or right branch. Look at the cesium-137. This is the leftmost branch. In a sense, this is simple in that there's no laboratory preparation that is needed. The samples come in in these bottles and they are calibrated to count the cesium in these bottles on our detectors, so, the sample goes directly to the detector, waiting for counting time. We have two intrinsic germanium detectors which are completely dedicated to this project. Nothing but ORERP samples are being counted on

them. They are inside shields and it has automatic sample changer built into this so that the bottles can be loaded on a conveyor belt and they will be counted in succession with no intervention by human hands.

The initial count for the cesium will be 300 minutes and we'll talk about this a little bit later. It's a bit more complicated than this. We can get about four 300-minute counts in per day and with two detectors, we can have eight samples counted per day. The spectra from the detectors are dumped from the detector into the computer and the computer does a spectral analysis, peak stripping. It will strip off the cesium-137 peaks and also the peaks from whatever other natural occurring radionuclides that are in the sample. This will give some cross-checks on how well this is being counted. Potassium-40 has a particular value and, if it's a factor of 10 off, something may be amiss. It will give something extra to check. The results come to the desk of the laboratory project officer and he reviews these results and an added factor is folded in. We do not normally take into account the density of the soil samples in our gamma analyses. For widely varying densities of soil, which I am led to believe we expect here, this can have an effect on cesium-137 by as much as 10%. Normally it's only a factor of a few percent. At any rate, we have an algorithm which will correct for the density and this will be incorporated at this point.

Once the results are finalized for the cesium, a letter is written and sent to DRI with the results. Now, normally this would be all but there is an added complication. The agreement is that we would like less than 5%, twice on accounting statistics error, for the total activity in the core. That folds in the top segment, the middle segments, and the bottom segment. Now, the way the activity is distributed, most of it's in the top segment. Very little, if any, is in the bottom segment. Now when you count the cesium in the top segment, 300 minutes will probably give you 3-4% counting

statistics because there's a lot of activity there. Then, that's fine.

The bottom segment, you could count it for days and you are not going to get that good accounting statistics, but you are safe because you don't really need it because there is very little activity in that part and when you fold in the total activity, that error is not very important. The problem is, we don't know what segment it comes from. Only DRI knows this, so we have to send the results to DRI and they look at their master log book to see where it comes from, and they fold in all of the errors and say, "Ah ha. This is fine," or "Ah ha, we need more counting on, say, a middle sample somewhere," so they will get back to us and say (that's DRI, it looks like ORI), DRI tells the lab to recount sample such and such, and we'll take that and recount it for a thousand minutes, and then it goes back to computer analysis, and follows through the flow diagram in the same way. Then we send another letter to DRI saying: "This is our new value. Is that ok?" and they will say "yes" or "no." If it's okay, the samples are stored.

The cesium analysis is nice in that it's nondestructive. You'll always have that dirt, no matter what. You can count it hundreds of times if you like. The plutonium is different.

A word about turnaround time. If we have 100 sites to be analyzed and each site has four segments, that's four hundred samples to be analyzed for cesium. We can do essentially four a day per detector. That's 100 detector days for the cesium and if you add in an extra 50% for QA, duplicate samples, split samples, whatever DRI wants to send in, plus some time for computer down-time, detector down-time, that gives you 150 detector days. Now you also have 1,000-minute counts. A 1,000-minute count takes up an entire detector day effectively, and it's hard to know how many of these we will need. An initial estimate might be 20% of the samples may need to be

recounted. Note that you don't really lose the 300-minute count. The total count time would be 1,300 minutes because you can fold the two numbers together. At any rate, this would be 20% of 400 is 80 samples, as an estimate; another 80 detector days, so as an estimate 80 samples per day for 150 days equals 230 days of testing and with two detectors, 115 days, so that's four months, approximately, depending on how many samples you want to send out.

Now let's consider the plutonium branch (32). The plutonium, of course, is a destructive analysis. Once we analyze this dirt, the dirt's gone forever. The plutonium we still have but it's in a form that's -- it's electroplated on platinum disks. The problem is that with the alpha spectroscopy, the alphas are absorbed into dirt so readily you have to have a very thin coating of the sample, so the sample -- the plutonium from the sample is electroplated on platinum disks and these are counted. The plutonium on that is saved and will go to mass spectroscopy which will determine the plutonium 240-239 ratios. As it stands, the plutonium will come in and we only need 200 grams for this rather than the 700 for the cesium and, in a sense, the procedure is simpler than for the cesium. We have this simple linear block diagram it goes down and in a sense, it's much more complicated because that first block is a big one. That's where the chemistry is done. It comes in, the EML chemical procedure is followed, which is a leach that we will talk about in a little bit, and at this point the sample is electroplated on a platinum disk. They are taken in to the counting room and counted on surface barrier detectors. These are 450 square millimeter detectors and they will be counted routinely for 1,000 minutes and we will get an energy spectrum of the alphas which will identify the plutonium-239 and we'll show you a spectrum in a few minutes. This data is dumped into the computer and is analyzed and the results are

reviewed by the lab project officer to make sure that it looks reasonable, there are no screw-ups in it. When the data has been certified, then a letter is written to DRI, and they receive the results of the plutonium. Bernie, let me have the next one. We'll go over these boxes one by one (32). This is breaking down the chemistry box. As soon as the sample comes in, it goes directly to chemistry and this is roughly what happens to it in chemistry.

(Figure 33). The initial box is the leach. What happens is that you dissolve most of the metals in the soil with acid. It comes off in the acid leach. You discard the rest of the soil. The second two boxes, essentially, do the same thing. They separate out the plutonium from all of the other draughts that came out with the acid. By the time that you get to the bottom of the third box, you have only plutonium. The bottom box is where you electroplated, and I'll show you our electroplating apparatus. This is where the plutonium is put on as a thin film on top of the platinum disk. Now, platinum is used because you want to do mass spectroscopy on the plutonium, and we normally use stainless steel, because it's much cheaper, but that interferes with the spectroscopy, so we do it on platinum and, of course, the platinum can be reused. It's not really lost.

I have some slides here. This is the initial step in the leach. We have the soil in the beaker and the chemist is pouring the acid in it. It gives you an idea of how much soil we start to analyze and this is normally done on a hot plate and it is done overnight. This is what happens to the soil once the acid goes in there. It starts foaming and working. It does this for quite a while. The way this is done, it's done in four steps. You put the acid in and you put it on a hot plate and heat it and leave it overnight, pour off the liquid which contains most of the plutonium and for

the residual stuff, you do the same thing again. Pour the acid in, heat it, let it sit overnight, and work. You do this four times. At the end of the fourth time, you have a white, I don't know what to call it, residual soil, a white mess here. Supposedly this has nothing else of interest in it and it's discarded. In the middle steps that I told you about, you need to separate the plutonium from the other material that was leached out with the acid. This is a key step. This is the resin columns. These columns, glass tubes in the background, are loaded with a resin which has an affinity for plutonium so that you pour your liquid through there, and the plutonium is absorbed on the resin, and nothing else, and then you can pour some material in it which will release the plutonium and you will have a solution which has, effectively, only plutonium in it.

We come to the last step and this is the electroplating apparatus. The plutonium liquid is poured into these little glass vials, here's one, here's one, here's one. The platinum disk is at the bottom of the vial. It's sort of held on with a rubber cover so that the platinum is effectively part of the vial. There is a platinum electrode that comes down from here, from here, goes down into the liquid and an electric current is kept between the two electrodes so that the platinum ions are electroplated on the bottom surface. This takes on the order of 5-6 hours, and we can do a number of samples at once. The little platinum disks are these shiny things that look like they are surrounded by the gold here. One here, here, here and here. That is what the sample itself looks like after the chemistry is done, and this gadget is the counter which does the alpha spectroscopy. The detectors themselves are the gold gadgets, here and here, that look up and the planchets are put face down over the detector and the detector can rotate under them so that we can count. This is an automatic sample changer. We can count a number of them without human

intervention although, since you are counting them at 1,000 minutes, that's of little help, although you can count over the weekend. We have four detectors in each one and, depending upon the sample load, we will more or less dedicate these four detectors to this operation. The chemistry is really the hang-up in the sample on plutonium and the hang-up in the chemistry is the leaching process because it takes a fair amount of space in hot plates and you need to do this in a hood because, obviously, you have intense acid fumes coming off and there's just so much hood space. We can do eight samples per month, or per week which probably is not going to be a hang-up; probably the cesium will take longer because you are going to do more of the cesium samples I understand.

I believe this is the last slide. Yes, it is. This is my last figure (33) and I wanted to show you what the data looks like, the plutonium data, which comes off the alpha spectroscopy. Now what we have plotted here, the vertical scale is the number of alpha counts in a particular energy bin, the horizontal scale are the energy bins. There are two peaks that are of primary interest here. This is the plutonium-239 and the plutonium-236. Now (Figure 33) these are truncated. The real peaks go quite a bit higher, but the upper parts are not of much interest. The way we do this, whenever you do the chemistry and the counting, you always lose some plutonium. You don't really know how much and this is a problem. You've got a recovery problem, so what you do is, at the beginning of the chemistry, you put in a known amount of something that's not going to interfere. We put in plutonium-236 because this follows the chemistry of the plutonium-239, it's counted with the same efficiency, so, we can compare the known amount of material that was put in here with the height of this peak, the number of counts in it, and that will give you an accurate measure of your total recovery, so, what we are really doing is looking at the ratio of this peak

to this peak and we can get an accurate number in disintegrations per minute of plutonium-239, which effectively gives you picocuries per gram.

A couple of things you should look at in this figure is the resolution of the spectra. If you have plating problems or detector problems, these peaks will get much wider and you will get overlaps and it's difficult to extract the information from them. The resolution here is on the order of 50-60 keV, if I remember correctly. There are other peaks in the spectra, obviously coming from thorium. I wanted you to see that they don't really interfere significantly with the plutonium-239 and -236. There is one small interference. This thorium-228 has a daughter which is radium-224. Radium-224 has a three-day half-life and it ingrows because it's eliminated in the chemistry, but as soon as you plate it, it starts ingrowing from the thorium. Its peak lies right here and can create a shoulder in the plutonium-236, so we have to account for the length of time between the plating and the counting and the ingrowth of the radium-224 and subtract that from the plutonium-236. If you do it within a few hours, it's essentially zero. If you wait several weeks, it can go into the same height as the thorium-228 peak which gives you an estimate of what kind of error you're looking at, but we can correct this.

One last point. The reason that you can't do plutonium-240 this way, and you have to go with the mass spectroscopy is that the energy of the plutonium-240 is the same as the plutonium-239. I should have written this 239 and 240. The 236 has a different energy but we are just unlucky in that 239 and 240 have the same alpha energy and you just can't discriminate between them.

That concludes my presentation. Are there any questions?

CHAIRMAN MOSELEY: Dr. Wrenn.

DR. WRENN: If you do radiochemical separation, why do you have so

much thorium showing up?

DR. THOMPSON: Well, the thorium, I believe, should be taken out, as I understand it, in the washing of the resin columns with hydrochloric acid. We can probably get rid of that by increasing that wash. For the details of the procedure you should probably ask Phil Krey. It's his procedure. At any rate, it only moderately interferes with what we are doing.

DR. WRENN: We do the same sorts of analyses in my lab and we use solvent extraction as opposed to ion exchange and our impression is that we don't have thorium interference.

DR. THOMPSON: I think we could get rid of the thorium by increasing the HCl wash. At least this is what my chemist tells me.

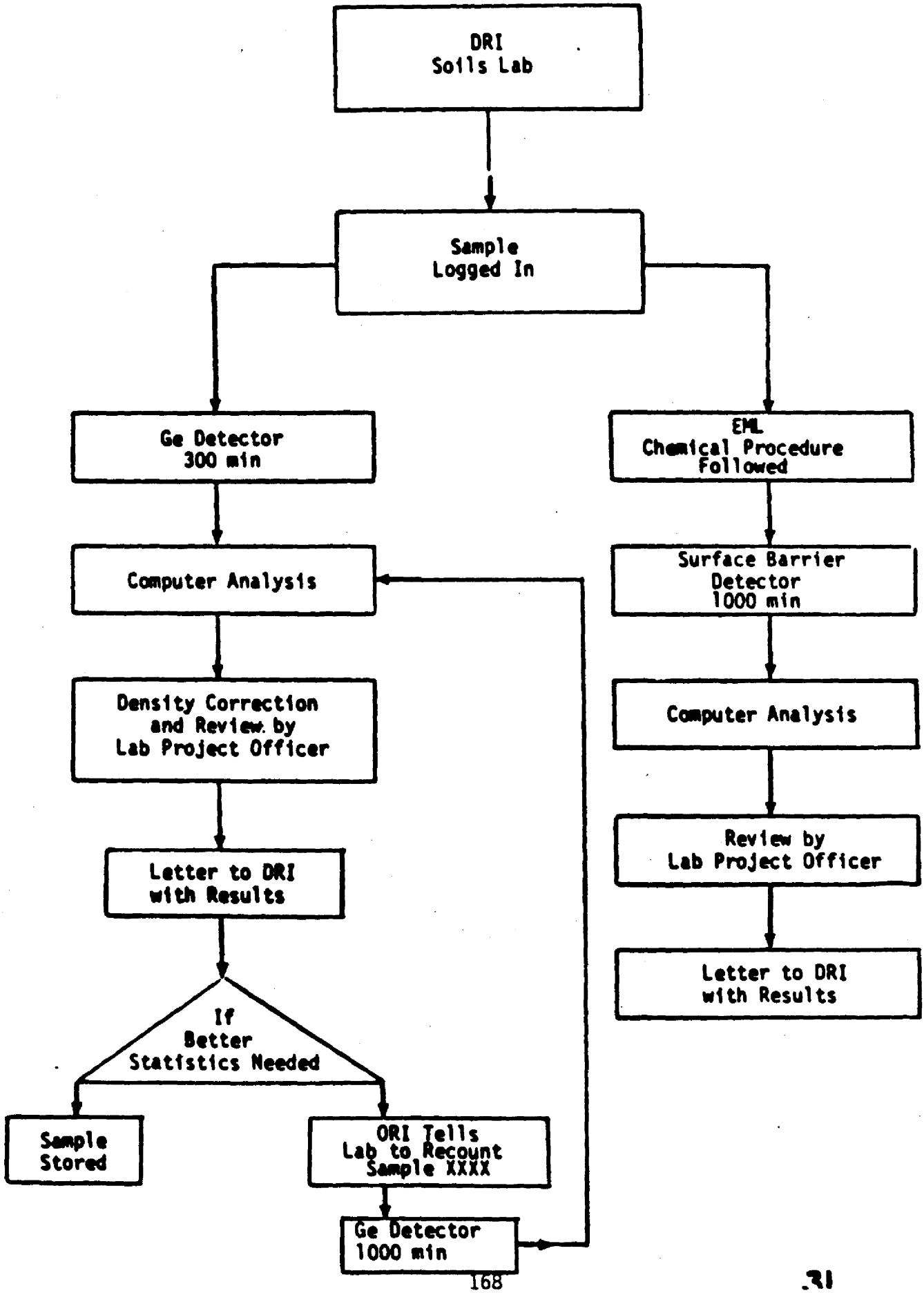
CHAIRMAN MOSELEY: Other questions?

MR. KREY: Phil Krey from EML. To answer Ed's question, Roger is correct in that the hydrochloric acid wash of the second column is the exact step which remains thorium. We have looked into the problem, as Roger has explained it, and have in our laboratory completely eliminated any thorium contribution so there is some little communication gap we have here. The other point is you saw a polonium peak on the spectrum which doesn't interfere with that and shouldn't really be there either and after you electroplate, if the platinum disk is heated correctly, you will vaporize any of the polonium and that will be removed also so you should, as you indicate, come up with a clean spectrum. Roger is also correct that if there is some slight contamination by thorium or polonium, it may not interfere with the analysis but from a purist's sense, it would be neater and should be completely clean.

CHAIRMAN MOSELEY: Any further questions? Thank you very much.

This brings us to an early lunch according to my schedule. We will reconvene at 1:15 p.m. back here.

(LUNCH RECESS 11:30 A.M.)


DRI
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Sample
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300 min
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Followed
Computer Analysis
Surface Barrier
Detector
1000 min
Density Correction
and Review by
Lab Project Officer
Computer Analysis
Letter to DRI
with Results
Review by
Lab Project Officer
Letter to DRI
with Results
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Better
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ORI Tells
Lab to Recount
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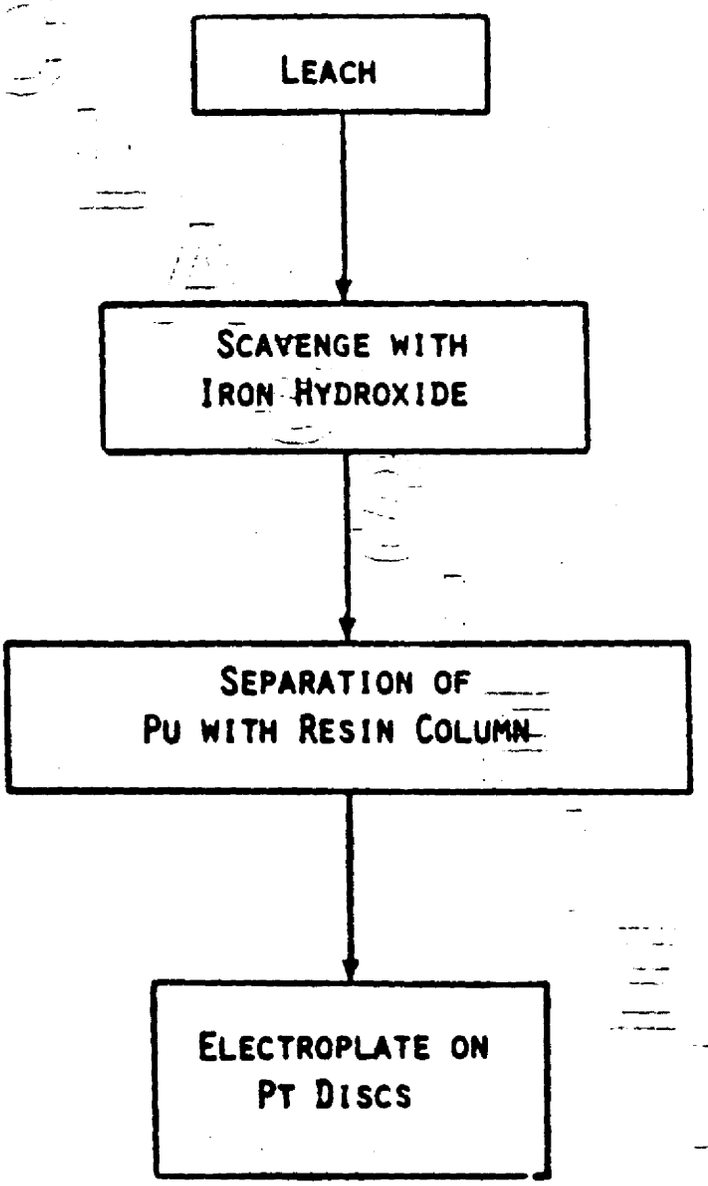
1000 min

EML

Pu CHEMICAL PROCEDURE



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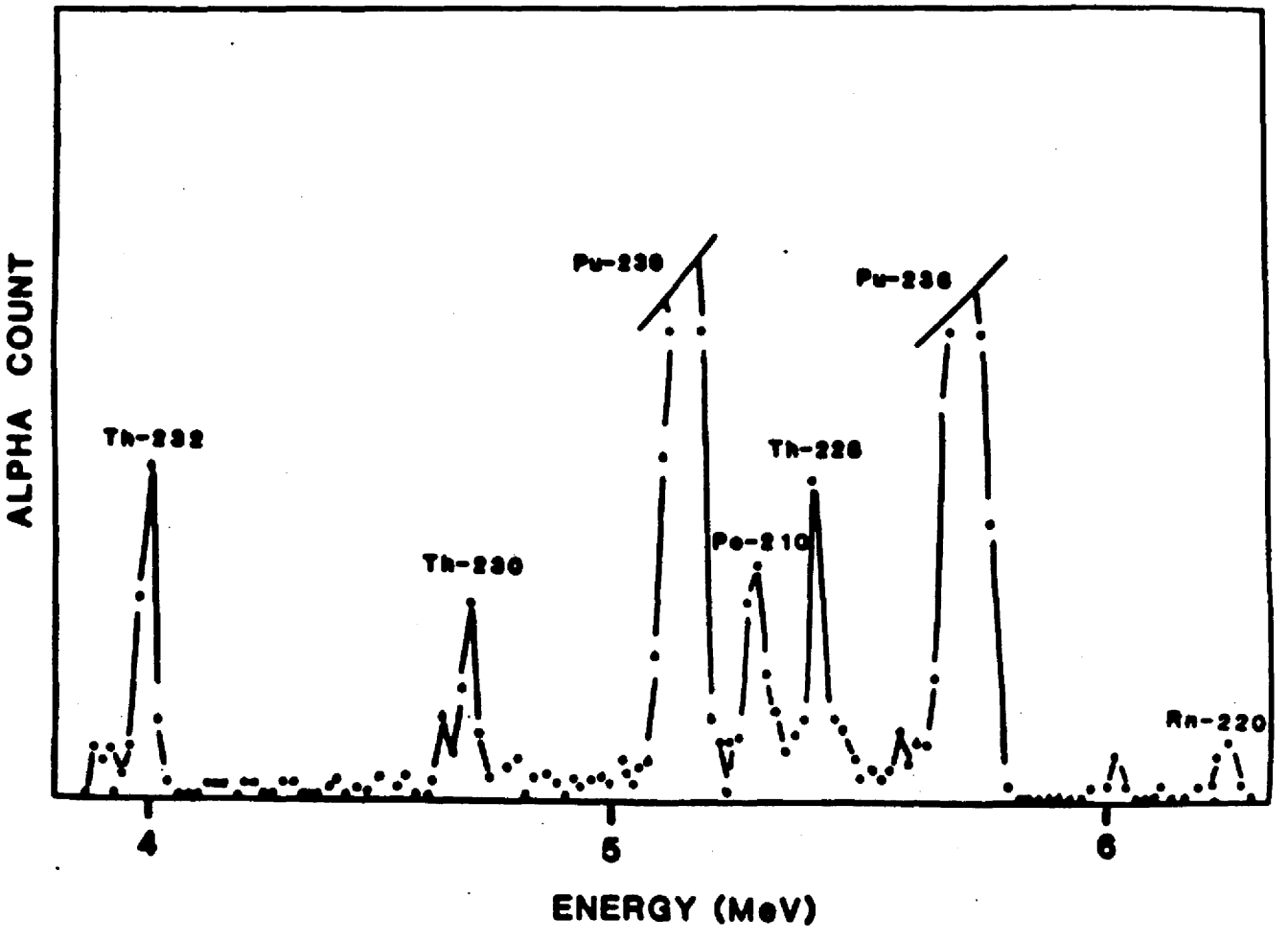
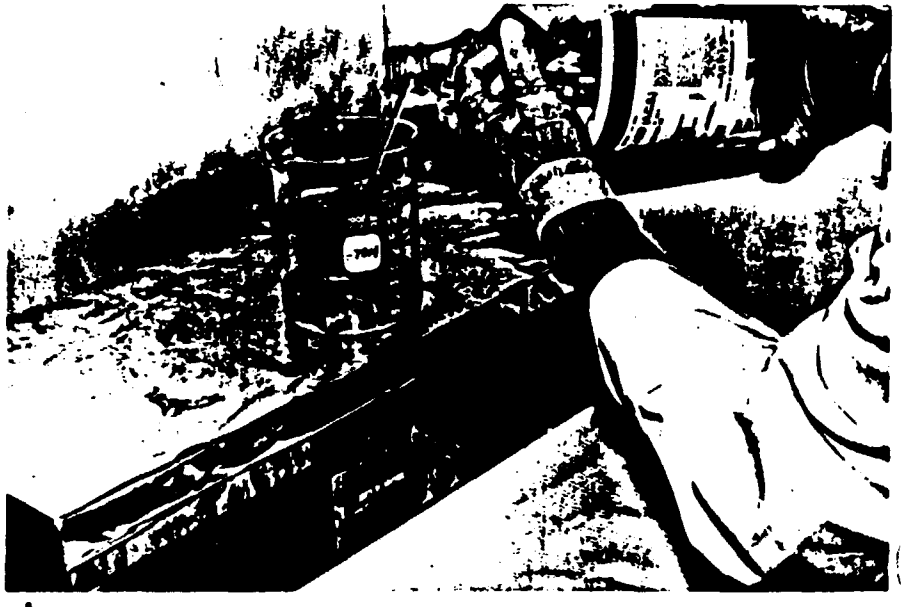

ALPHA COUNT
Th-232
Th-230
Pu-238
Po-210
Th-228
Pu-236
Rn-220
4
5
6
ENERGY (MeV)

33



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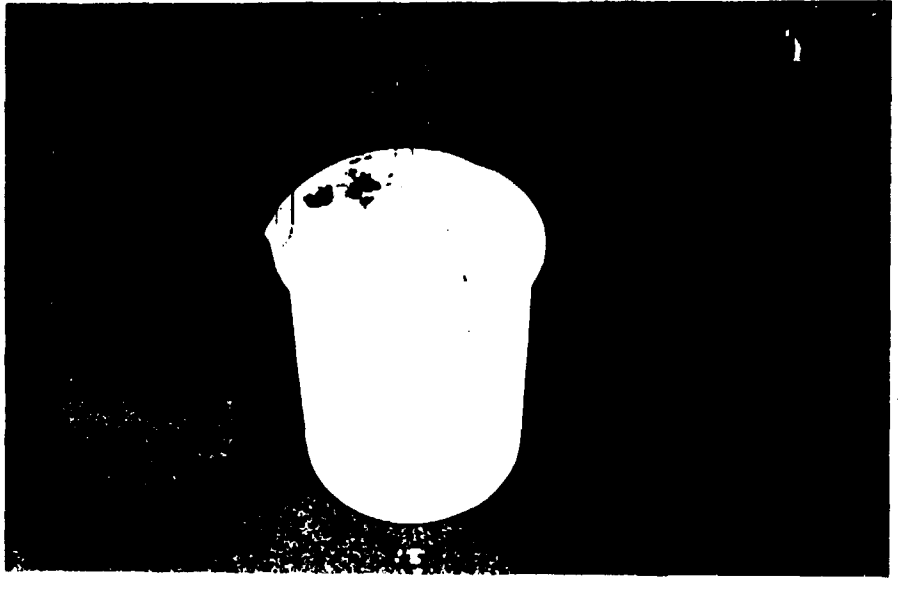

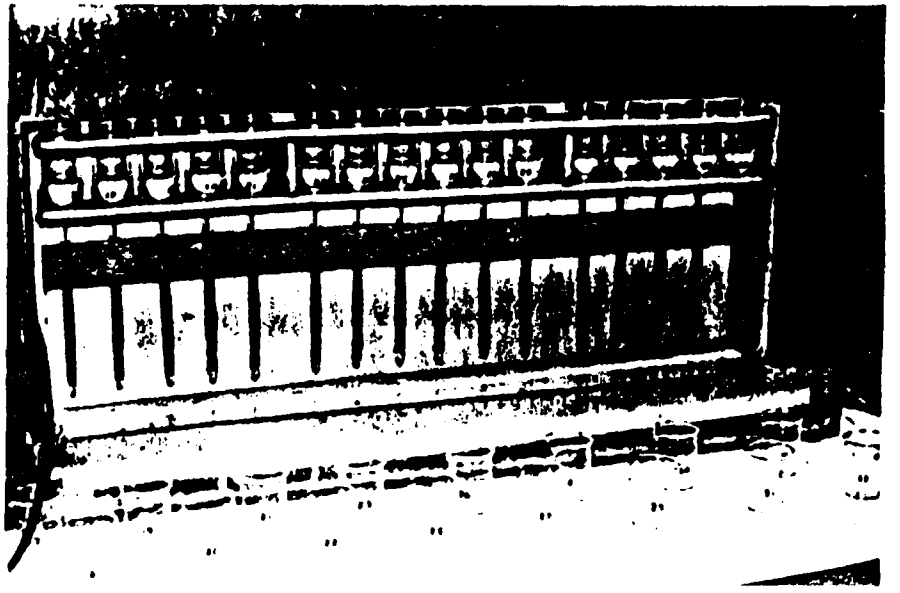

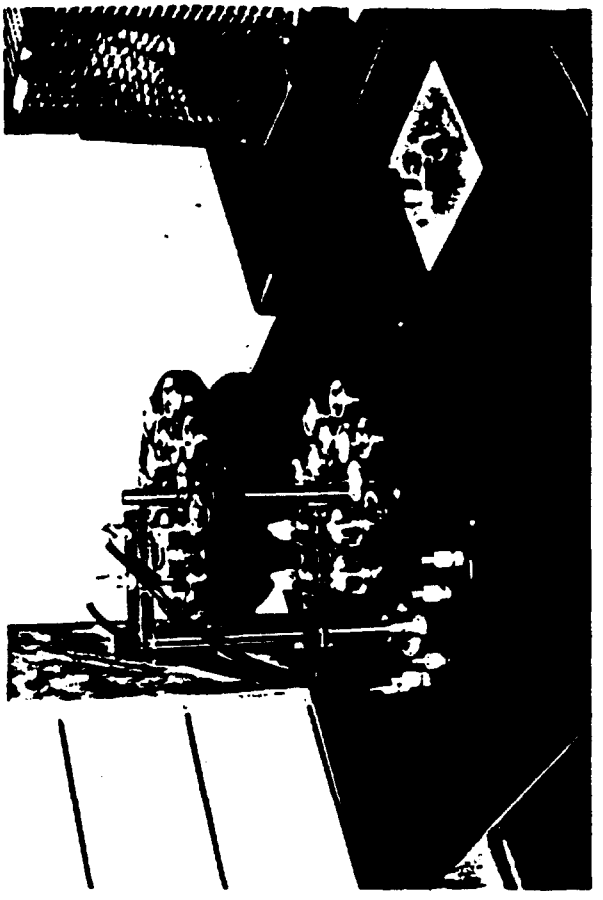

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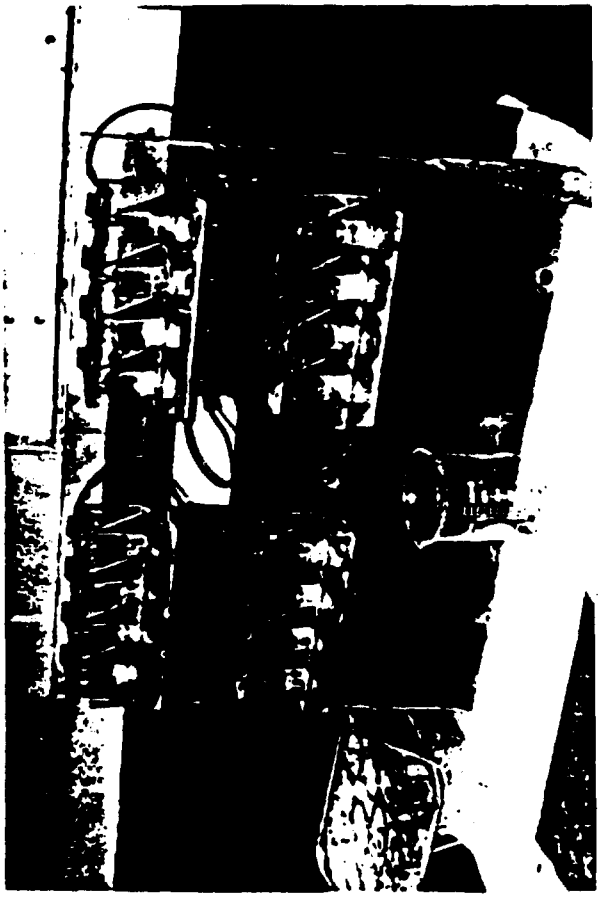


E

AFTERNOON SESSION

CHAIRMAN MOSELEY: My apologies to all of you. Most of the members of the Dose Assessment Advisory Group made the mistake of having lunch together today at one table and that slowed things down considerably. I will have to say that by fiat in this case, I denied dessert to the entire group so that they are going to be maybe more disgruntled and less cooperative this afternoon than they might have been had I been more generous with their time.

We will continue with the Soil Analysis Program and Forest Miller will talk about a Description of the QA Program for the Soil Analysis.

DR. WRENN: Mr. Chairman.

CHAIRMAN MOSELEY: Dr. Wrenn.

DR. WRENN: May I make a quick comment that dealt with the last presentation?

CHAIRMAN MOSELEY: Please do so.

DR. WRENN: I have an observation which is intended to be helpful to the effort. I have spent a considerable number of years measuring radiocesium in soils by gamma spectrometry myself when at New York University, and we developed a technique, and I will furnish a published paper to the ORERP if they would like it, which dealt with measuring radiocesium at these levels, fallout, in small soil samples, 20 grams, using sodium iodide as opposed to lithium drip to germanium crystal and the advantage is greater sensitivity and greater speed of analysis. The equipment and technique still exist at New York University and I will be happy to furnish a contact there. I know Mr. Krey knows the group very well and it might be useful for screening purposes with respect to a large number of samples like this and as a cross check on some of the results, but, conceptually,

one could go through a hundred samples in a period of a week or two as opposed to a longer time period, and I'll furnish the reference later.

CHAIRMAN MOSELEY: Thank you, sir.

DR. MILLER: I want to talk for a very few minutes on what you might call the flow of information through the soil analysis procedure and to indicate where the QA samples will come in.

Beginning at the top of the page (FM-3) DRI as sort of a broker will combine the QA soil samples from EML with the prepared samples from REECo, renumber them, and send them through the soil preparation phase. After the soil preparation, drying, ball-milling and sieving is completed, then the 700- gram aliquot will be drawn for gamma analysis and the numbers that are put on the samples by the initial brokering will be laboratory analysis numbers and they will carry straight through the gamma analysis and the results will come back to DRI where we will decode and decide whether the precision criterion was met. A certain percentage of the samples will be recounted at EML to check for bias. After that decision is made, we will decide whether that particular soil sample is going to be submitted for plutonium analysis and that's not a DRI responsibility, but it's going to be a group responsibility. If not, the remaining sample will be sent to storage. If so, we'll do the preparation for plutonium analysis which, essentially, means drawing another 200-gram aliquot from the remaining sample. That sample will be relabeled with a different chemistry laboratory number and those samples will be blended with QA Pu samples from EML and sent for plutonium analysis. Again the data will be decoded and the remaining samples will be sent to storage. This is basically the external quality assurance procedure using EML and it will check for both bias and precision and also for contamination, the cross-contamination of the samples because blanks will be sent through.

In addition there is a REECo internal quality control procedure. For instance, the analytical balance in the soil preparation area has a quality control program going on it. There will be resampling of a large batch of soil recently taken at Hurricane and both plutonium and gamma analysis samples will be sent through on a periodic basis. Given that the plutonium analysis can handle eight per week, eight samples per week, one of those will be an external quality control sample, and one of them will be an internal quality control sample.

We have designed an experiment to address a problem in precision of analysis in the REECo laboratory. The experiment, essentially, is a basic analysis of a random components design and should allow us to determine at what part in the REECo plutonium analysis procedure, the uncertainty is creeping in. Perhaps I could stick this up here (FM-4), probably not too many people care too much about this, but for the statisticians in the crowd, this is what R. L. Anderson calls a staggered experimental design. We will take eight 200-gram aliquots, four of this kind, two of this kind, one of each of those kinds. Everytime there is a fork in there we split the sample. You notice that we split one of the samples 16 times and the two analyses here will give us an estimate of the variability due to the plating step. The split here will give us a column-extraction variability estimate. The split here will give us a scavenging-variability estimate, and this will give us, directly, an aliquoting estimate, or have I skipped one, leaching. I have laid out here, given that this is Type 1, where the degrees of freedom with respect to the experimental design go and for Type 2, Type 3 and Type 4, and what we have at the end of the experiment is an almost equal number of degrees of freedom for estimating each of the variance components. An additional nice property of this experimental design is that the estimates of variance components are not correlated,

given that our model is correct, namely, that we have additive effects. Any questions?

DR. KORANDA: How are you going to split those samples, Frosty?

DR. MILLER: Well, I'm not going to do it physically. That's going to be part of the laboratory procedure, and they've assured me that at each step they can split them.

DR. KORANDA: Do they have a riffler to do that?

DR. MILLER: Well --

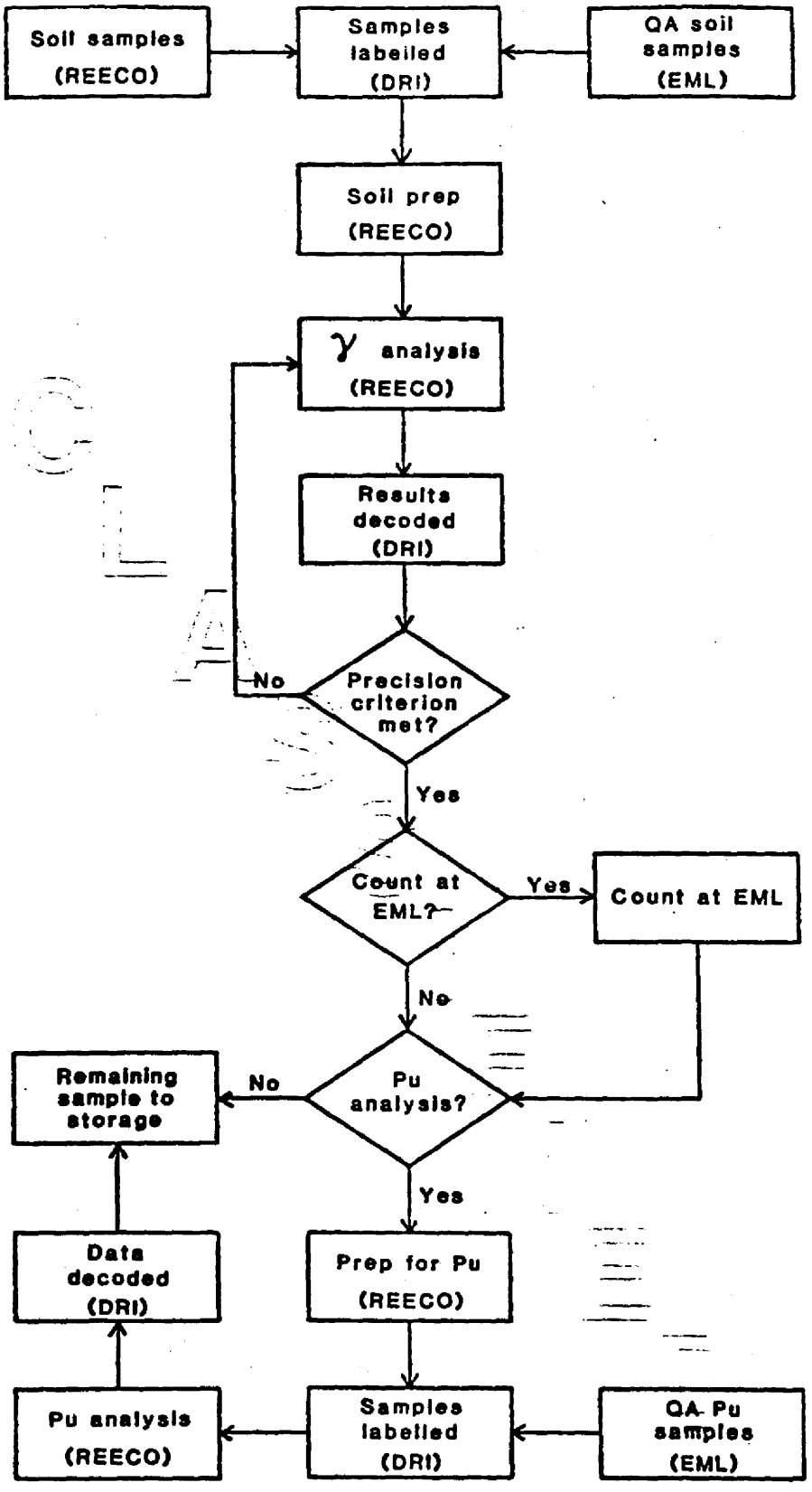
DR. KORANDA: It's pretty hard to get representative subaliquots when you have that many splits.

MR. KREY: These are solutions, at this point.

DR. KORANDA: Well, it's not hard to split a solution. There are solutions and solutions.

DR. MILLER: Right. The aliquoting -- the initial aliquoting of the eight samples, that will be done in a standard manner, is going to be done for the ORERP samples, and that will provide us with an estimate of the variability induced by that; and given that soil homogeneity, or the lack thereof, is a standard problem in these sorts of analyses, I think it's desirable to have an estimate of the variability that occurs when that happens and, in particular since we are drawing 200-gram aliquots, the variability that we estimate from here will be directly applicable to the uncertainty in the plutonium analyses of our standard samples.

CHAIRMAN MOSELEY: Thank you. Questions?


Soil samples (REECO)
Samples labelled (DRI)
QA soil samples (EML)
Soil prep (REECO)
γ analysis (REECO)
Results decoded (DRI)
Precision criterion met?
No
Yes
Count at EML?
Yes
Count at EML
No
Pu analysis?
No
Remaining sample to storage
Yes
Data decoded (DRI)
Prep for Pu (REECO)
Pu analysis (REECO)
Samples labelled (DRI)
QA Pu samples (EML)

FM-3

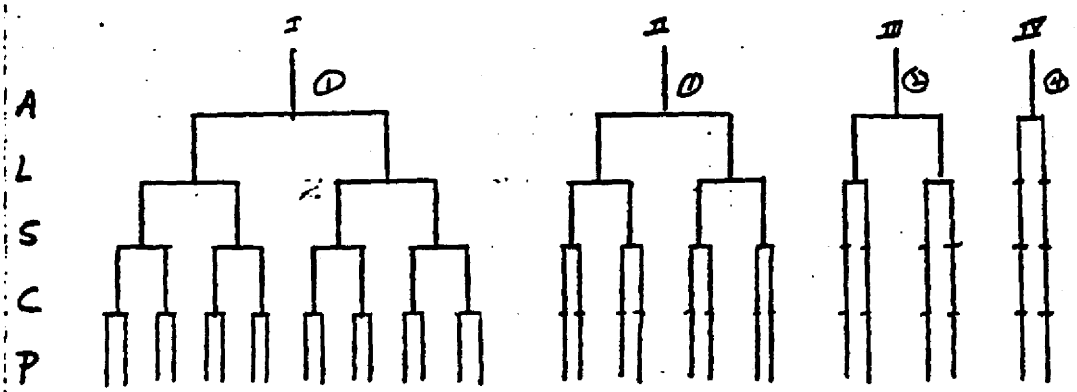
A is Aliquoting

L is Leaching

S is Scavenging

C is Column Extraction

P is Plating



DF	I	II	III	IV	TOTAL
A	0	0	1	3	7
L	1	1	2	4	8
S	2	2	4	0	8
C	4	4	0	0	8
P	8	0	0	0	8

(INCLUDES 3 DF FROM COMPARISONS BETWEEN I TO I

$$Y_{ijklm} = \mu + A_i + L_{j(i)} + S_{k(ij)} + C_{l(ijk)} + P_{m(ijkl)}$$

FM-4

CHAIRMAN MOSELEY: The next presentation is a rebuttal by EML.

MR. KREY: At the request of the DAAG and the ORERP, EML has agreed to assist and participate in the quality assurance plan for Phase II.

As Frosty indicated, DRI is indeed responsible for the conduct of the quality assurance plan, but we have been, and we will continue to be active in the design and logistics of that plan.

The first viewgraph, if you will (A). This identifies the various subtasks in the experimental approach to Phase II. These are the site selection, the in situ gamma spectrometry, soil sampling and sample preparation, cesium-137 analysis, and plutonium 239-240 analysis. I have left off in that viewgraph one other task which will be coming down the road much later. That is the mass isotopic analysis of the plutonium 239 and 240 nuclides. That's far down the road, and we'll address that when the time comes, but it will be part of this subtask.

EML has been involved in each of these tasks in one of three ways: instruction, reference samples, and duplication. As part of this plan, EML has provided written instructions to each of the appropriate ORERP groups for each of these subtasks, as far as the EML standard methods are concerned. In reference samples: at the present time to allow REECo to test its analytical methods prior to proceeding with the actual Phase II samples, we have provided them with typical samples which have been analyzed under previous EML programs. In the future we will provide reference samples and blank samples to DRI who will then insert them blind into the normal sample flow to the analytical contractor. As far as duplication is concerned, EML has intercalibrated its in situ gamma spectrometry system with the system from Livermore at a number of sites. In October, we have collected or retrieved soil samples from 13 sites where REECo had sampled earlier. These particular samples will be processed and analyzed at

EML for comparison of the final results with the values provided by the ORERP teams. From some of the discussion that we heard this morning and our observations, I think that the site selection subtask has been done quite well. In the in situ spectrometry, we have had no observable problems. The soil sampling I think has been done very well. I've seen the people collect soil samples and I hope we can do as well in the future. The sample preparation is different from the kind of preparation that EML has done in the past; however, I believe that the REECo method is quite adequate. We've set certain criteria that this method should satisfy and from some of the data that I have seen today and yesterday, it appears that it is adequately satisfying these criteria. A few more analyses will be helpful, but I am quite optimistic that that is quite adequate.

The next viewgraph (B) summarizes the test results for the REECo cesium-137 analysis. We submitted one blank sample which indeed reflected no detectable activity. However, one sample does not make a case obviously. I should also point out that this particular sample was simply counted on a gamma spectrometer and was not subjected to the possible contaminating rigors of sample preparation. From the analysis of two sets of duplicate aliquots, the precision of the analysis was within the counting statistics which is on the order of 2-3%. From the analysis of six samples, there appears to be a slight positive bias of REECo over EML, about 5%. We intend in the future to continue making comparisons to firm up that bias if it exists, which it looks like it does, and if it does exist, to make the appropriate correction in the future. We don't feel that this is a serious problem, however.

The next viewgraph (C) summarizes the test results from the REECo plutonium analysis. From the analysis of three blank samples, they reported no detectable activity. However, on the analysis of one blind Utah sample,

they reflected a contamination level of about ten times the value that you would normally expect from these kinds of samples. The actual source of that contamination has never been identified. After this incident, REECo thoroughly cleaned their laboratory and that situation has not since recurred. Hopefully it was a freak occurrence and the quality assurance plan that we intend to follow, that DRI intends to follow, will address this question very carefully.

The analysis of three sets of replicate samples indicated that the precision of plutonium was an unacceptable 20% and this must be improved before routine analyses of Phase II samples can begin and, as Dr. Miller indicated, DRI and REECo have a plan to address this question.

From the analysis of twelve samples, there does not appear to be a demonstrable bias between REECo and EML. The weighted average of 1.05 ± .03 seems pretty adequate and is certainly not demonstrable to be a bias at all.

The next viewgraph (D) identifies the 13 sites at which EML has recently recovered the soil samples where REECo had sampled earlier. We will process and analyze these samples at EML for ultimate comparison with the results from the ORERP teams. The sites with the blue circles represent locations where EML collected a duplicate sample. I know that REECo has also collected a sample at Touelle -- and I'm not sure that I can see Touelle but somewhere up around here, I can't see but somewhere up around here -- I know that next year they are planning to revisit a number, perhaps six or seven additional EML sites that were sampled in Utah in 1979. So by the time that Phase II is over, we should have something on the order of 20 or so sites where EML and REECo have sampled identical locations. These particular sites were selected for several reasons: one on a geograpical basis such that two EML teams could adequately reach these

sites within one week's sampling time. The other was that we hoped to collect samples at sites that reflect relatively high, intermediate and low level NTS fallout. The sites at Alamo, Caliente, Ely, Eureka, and Austin probably reflect sites with a relatively high level of NTS debris. At Wendover, Wells, and Elko, there are probably sites with an intermediate level, and here at Boise, Twin Falls, Malad City, Idaho Falls, and possibly Fredonia, Arizona, might reflect sites with relatively little NTS fallout.

That's all for the viewgraphs.

As the analytical work proceeds on the actual Phase II samples, EML will supply DRI with reference material, reference soil samples and blanks for the blind insertion of samples to the analytical contractor.

The reference sample is a 20-kilogram composite of a sample retrieved in northeastern United States which has been processed and analyzed at EML. Approximately 200-gram samples of this composite, a large sample, will be supplied. The physical appearance of this sample should not be readily distinguishable from the appearance of the normal Phase II samples.

The appropriate quantities of a blank sample will be submitted to DRI, appropriate quantities in the sense of the various depth profiles, 0-5 cm, 5-10, 10-15 and 15-30. These samples will be in a different fashion from the reference samples. These blank samples will be processed throughout the entire soil handling and analysis procedure to monitor every possible aspect of contamination. The reference samples will simply go directly to measurement -- cesium measurement and plutonium analysis. The blank samples will be processed through the soil-handling techniques from the outset. This soil was recovered several feet underground at an excavated pit in Chester, New Jersey where EML maintains an environmental research station. Under the radioassay criteria for this project, these samples should reflect no detectable cesium-137 activity.

Finally, to better quantify that slight bias in the cesium-137 measurement, we will analyze another 20 or so samples for cesium-137 and these samples will be the exact samples that REECo will have analyzed for their estimate of the cesium-137 content. Using the exact same sample will eliminate any complication with regard to aliquoting. It will be the same sample analyzed by both labs. Are there any questions?

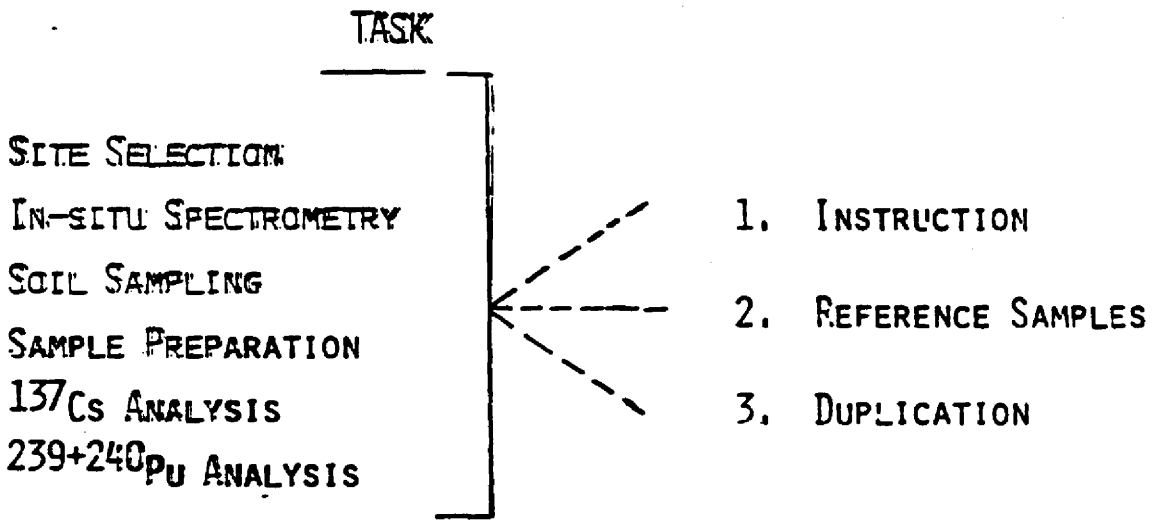
CHAIRMAN MOSELEY: Bruce.

MR. CHURCH: They are going to mail you that same sample. Is that what I understood?

MR. KREY: That is correct. Frosty Miller will identify what samples will be shipped to EML. I must admit at this very moment that I'm not sure whether REECo will submit that sample to us directly or whether he will get it back to DRI for renumbering and then sent to us. The detail I'm not exactly sure of at this moment. That might be a better approach in that we would be completely blind, also, but, in either event, it will be the exact same sample.

CHAIRMAN MOSELEY: Any other questions? Thank you very much.

QUALITY ASSURANCE PLAN



A

^{137}Cs QUALITY ASSURANCE

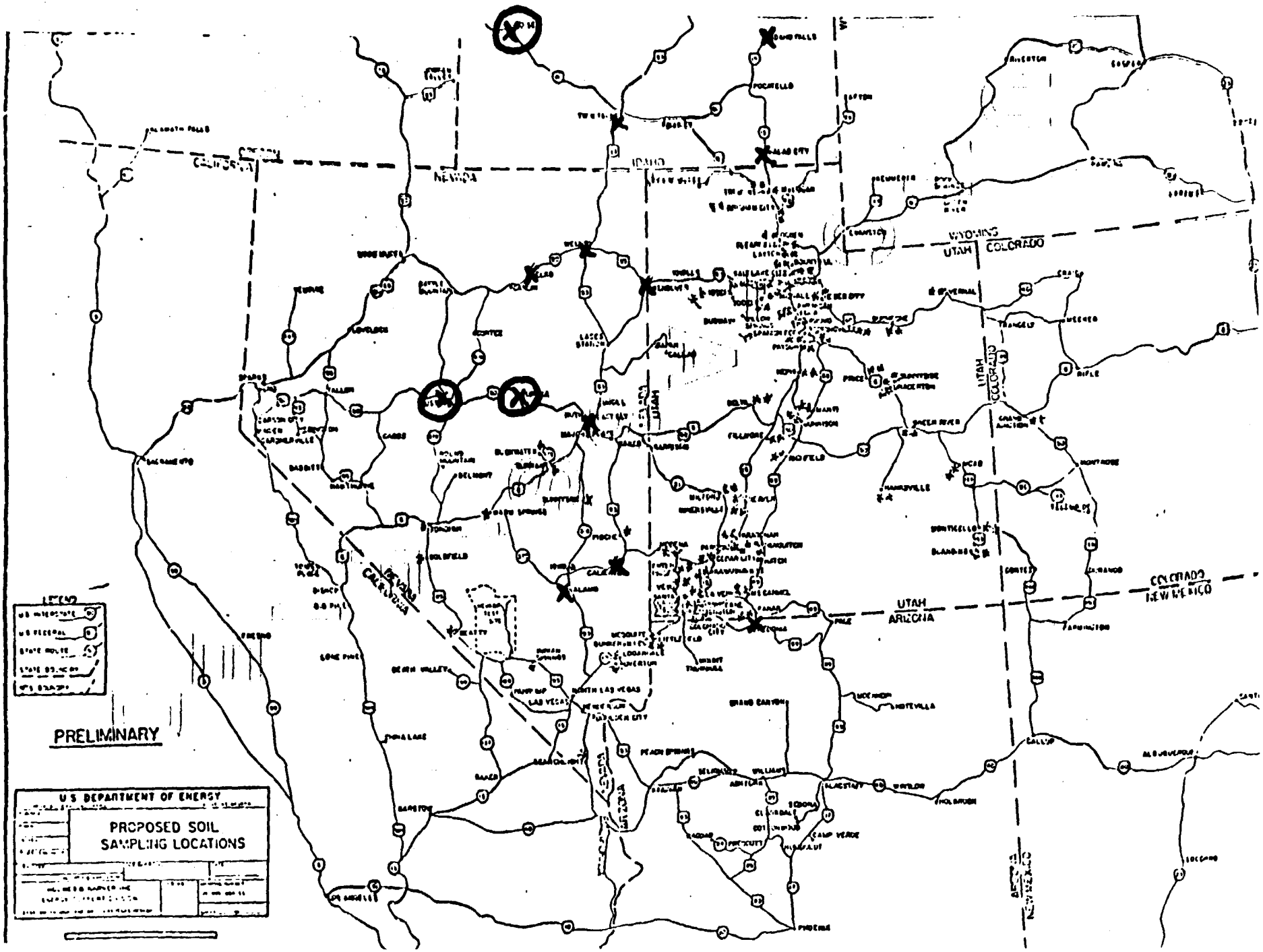
		No. of Analyses	Assessment
Blanks		1	M. D.
Precision	Duplicates	2	2 - 3%
Bias	REECO/EML	6	1.05 ± .01

Pu QUALITY ASSURANCE

		No. of Analyses	Assessment
Blanks:		3	N. D.*
Precision	Replicate	3	~20%
Bias	REECO/EML-400	12	1.05 ± .03

*ONE UTAH SOIL REFLECTED A CONTAMINATION OF 10X AVERAGE Pu CONTENT.

C


PRELIMINARY
U.S. DEPARTMENT OF ENERGY
PROPOSED SOIL SAMPLING LOCATIONS
IDAHO
NEVADA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO

CHAIRMAN MOSELEY: Dr. Anspaugh is going to speak regarding the Selection of Approximately 100 Soil Sampling Sites.

DR. ANSPAUGH: Before I go into my primary topic, I would like to briefly go back, if I might, to another topic. Being handed out to you is a second draft of our Historical Estimates of Exposure to the Offsite Population (UCRL-87380-Draft Rev 1). This was originally handed out at the meeting last May, and primarily in response to some rather lengthy, and very well-taken comments from Dr. Auxier, we have extensively modified that paper. The primary table as it was originally handed out had only the estimates of population exposure. We've gone back and included not only the total population exposure, but also the cumulative estimated exposure. These are the tabulations of the original Vay Shelton or Test Manager's Committee to Estimate Fallout Exposure recast so that we can look at them in terms of population exposure as well, so we would like to submit this paper to Health Physics and if we could ask the Committee to review that and make any comments, if they would, we would certainly like to proceed with submitting that paper.

Back to the topic of interest, the selection of the 100 locations for further analysis. With your indulgence, Mr. Chairman, I would like to spend a few minutes perhaps reviewing exactly what we intend to get out of this whole soil sampling and analysis program and why it was really undertaken, if you think that's appropriate.

CHAIRMAN MOSELEY: I can't give you that permission unless I ask you a question.

DR. ANSPAUGH: Okay.

CHAIRMAN MOSELEY: This is external exposure?

DR. ANSPAUGH: Yes, it is. Only external exposure.

CHAIRMAN MOSELEY: Then you may go ahead with it.

DR. ANSPAUGH: Okay. If I may have the first viewgraph, David. (LRA-41).

From our original discussions, I think at the very first meeting of this Committee and even its predecessor committee, we wrestled with the problem of what do we do about areas that are really beyond the original estimates of exposure, external exposure, and how do we deal with it and how far do we go. I think we always agreed that additional measurements would be useful. This is actually an old viewgraph, from many meetings ago, and we generally concluded that it would be useful to have contemporary measurements of the deposition of radionuclides in a broader geographical area and I don't think that we have ever come to a reasonable way of saying where we will draw that line, but, nevertheless, I think that everybody felt that the original fallout patterns were not extended far enough to answer all of the questions that we had.

Some of the methods that we proposed were aircraft measurements, field spectrometry and soil sampling. As it turns out, we are actually pursuing all of these methods. Harold Beck discussed the analysis that he is doing of the NURE aircraft data and the Phase II that we initiated following the May meeting has extensively used the techniques of field spectrometry to measure the cesium flux and also soil sampling so that's just to emphasize, again, that this whole process is being undertaken to extend the region where we can calculate doses.

The next viewgraph (LRA-42) indicates the dose determination methodology that's based upon these techniques and this, I would like to emphasize, is based upon the work that EML has done primarily, and their demonstration of this technique throughout Utah, but, basically, the key to this whole business is to calculate the amount of cesium-137 that arrived at a site at some estimated time of arrival. Now, if we can in fact cal-

culate the estimated cesium that came from the Nevada Test Site, we can go back to our standard source term calculations and we can, indeed, calculate in a reasonable way the short-lived radionuclides that came with the cesium that were responsible for the dose, and, again, just to emphasize, it's the short-lived radionuclides that are responsible for the dose and not the cesium. The cesium is our track of what's still there and we can measure with contemporary measurements. Once we know Number 2, we can then calculate Numbers 3 and 4 with our standard methodologies.

The next viewgraph (LRA-43) indicates the two methods that EML has come up with and successfully demonstrated in Utah. If we know, on the basis of the current measurements, the total cesium that's in the soil now; and if we have a reasonable idea of when it got there, we can, of course, calculate backward how much was there originally. The first method assumes that global cesium primarily comes down with rainfall and that if we do know the rainfall at a particular location, we can use a regression equation that EML has developed to estimate the global; and then the cesium that came from Nevada is simply the difference between the total and global. The other method is based upon current measurements of plutonium deposition as well as the cesium-137 and the ratio of plutonium-240 to -239.

The next viewgraph (LRA-44) is an indication of why that ratio should be different for global fallout as opposed to that that came from the Nevada Test Site, and, basically, plutonium-239 is made in reactors with the bombardment on uranium-238. The longer you leave it in the reactor, the more plutonium-239 is created from uranium; and at the same time if you have created plutonium-239, you leave it in the reactor, and you eventually build up levels of plutonium-240 by two different methodologies. The level of plutonium-240 is a reflection of the neutron flux that the plutonium has

seen and the uranium, in this case, as well, as if we talk about global fallout, it's mainly due to thermonuclear explosions which produce a very large neutron flux and substantially change the ratio of plutonium-240 to -239. Now, from the Test Site, we essentially have all fission devices that did not produce such large neutron fluxes, so that's the basic reason why the ratio of plutonium-240 to -239 is different for the Nevada material as opposed to global fallout.

The next viewgraph (LRA-45) are some material from EML that I won't go through in any great detail. It's been presented a couple of different times, but, just to emphasize that this technique has been worked out by EML that you can calculate the ratio of (total) plutonium from Nevada to that of global if you measure several different things and that includes the ratio of plutonium-240 to -239 in your sample and then you know what it should be for global fallout, and what it should be for Nevada fallout. Going through this arithmetic, you can calculate on the basis of these measurements and those knowns, the ratio of plutonium from Nevada and global fallout in that sample, and these are the values that EML has provided us as the constants for the Nevada fallout and for the global fallout. You see that the ratio from the two sources differs by about a factor of 6.

The next viewgraph (LRA-46) is simply an extension of that. The other equation is that the total plutonium in the sample has to represent the sum of the two sources; combine that equation with the other one, and then you can come up with the amount of global fallout in that sample and then, what we really want is now this number, whereas if we know the global plutonium in that sample, and also the total cesium, we know the ratio of cesium-plutonium in global fallout, shown there, and then we can, indeed, calculate this number, which is the number we need to drive our dose

calculations and we can also compare that number with the number that came from the rainfall method.

And the next viewgraph (LRA-47) shows the steps in this measurement strategy of what we now call Phase II. We select the desired communities. Those were selected on the basis of geographical coverage where we had a feeling that the fallout might have gone. Areas were selected essentially to provide a circle around the areas that we have been measuring so that we did select about 100 communities where we felt it was desirable to look for a soil sampling site. Frosty's group then went out, selected these candidate sites. They were followed by the Livermore people, and EG&G also assisted in this operation, to measure cesium-137 by field spectrometry. That's mainly a confirmatory technique to make sure that that sample does have a representative amount of cesium in there because if it has been seriously disturbed then we essentially get very little values of cesium, and we would not take soil samples at that site. On the basis of that, we then select sites for soil collection, collect the soil samples, we select sites for following analysis by laboratory methods. We have just finished Step 6. Last May we essentially had just done this part (Step 1), and so we've been very busy since the May meeting doing all of this measurement by field spectrometry and collection of soil samples. We now have picked these sites (for Step 6), and I'll get to them in a moment, which ones they are, and then we'll follow that with our cesium measurements. In the soil samples we'll look at the distribution (of cesium) with depth. We can go back then and calibrate our field spectrometry measurements, and once we know the distribution with depth to get a semi-independent measurement of the total cesium deposition. Now on the basis of this measurement (Step 7), if the distribution with depth continues to look reasonable and provides us with confidence that that site has not been further disturbed,

then we will proceed with these other analyses, the more expensive analyses of plutonium and plutonium isotopic composition.

The next viewgraph (LRA-48). On Wednesday our Site Selection Committee met to select the sites for the laboratory analysis of cesium-137, and those were the members of the Committee. I think Harold Beck and Phil Krey with their experience from doing this already in Utah probably provided the most valuable input at this meeting. Howard Hawthorne was involved in the soil sampling and was responsible for that program; also a very important input. Frosty, in the inital selection of the site and questions about verifications of age, and so forth. We provided the in situ measurements, the field spectrometry of the cesium-137, and then the folks from NV. That was the Committee. We met all day, and we did run through several hundred prospective sites and reached agreement in a rather amazing fashion, as it turned out.

The next viewgraph (LRA-49) basically looks at the soil -- the site selection criteria. Now the first four here were the criteria that we had before we even went into the field. In essence we are looking for large areas of open, which have a consistent ground cover of lawn as our first priority and away from obstructions, such as buildings and trees, and so forth. An absolute requirement, as much as it can be positively verified, is that the sample has been undisturbed since the testing began. We certainly have a fundamental reason for wanting to look at the total cesium that has been deposited on that site. So that that is a very strong criterion. Other criteria, three and four, are that the site is not subject to erosion, and it's not subject to accumulation. We want definitely a site that retained the fallout that fell on it and did not lose it by erosion and did not accumulate it by sedimentation, from waterborne material, or by windborne.

Now after we have a preliminary site selection then the fifth criterion is that the field measurement confirms at a reasonable level that cesium is, indeed, present at that site. And finally, a sixth criterion that is very important is that the soil sample is collected successfully. Howard talked about several different kinds of problems. I think the worst problem is that there might be a serious problem of crosscontamination of samples; that the hole sloughs off, and you get relatively high activity material that falls down and contaminates the lower levels. So that if the soil sample is not collected successfully, that's reason for rejection of that site.

The next viewgraph, please. (LRA-50). This shows our current results in terms of numbers. We started out with 105 desired communities, target communities, if you will, that we felt it was desirable to include. Frosty's people went out, and according to my tabulations, selected 316 candidate sites attempting to look at more than one site within each community, so that we had more than one choice if we encountered other kinds of problems. Actually measured by field spectrometry were 276. On the basis of those numbers, if we had three sites in a small community, and they all had the same flux, then we only chose to, say, sample one of those sites for soil; so that there was a considerable reduction in the total number of sites that were actually selected for soil sampling.

In our present process now we've gone through, we had a target of 100 sites, and we actually selected 102 sites for lab cesium analysis. Four of those are questionable in terms that they need further verification; so that we may have 98-102 sites depending on how those verifications turn out. That's mainly verification from somebody who will say that in their memory that site has, in fact, been undisturbed since 1950.

The next viewgraph, please. (LRA-51). Now this is a summary of these

selected soil sampling sites by state and type. Now, I haven't really referred to the types before. A type-A site is one that we feel meets the criteria that I showed before. Now a type-B site meets most of the criteria, but it becomes a little bit questionable for one reason or another, but because the type-A site was not available, or in some cases because we wanted to compare the two types of sites, we have chosen some type-B sites. One of the handouts you have is a list of these 102 sites and just some reasons here for why something might be a type-B site. You can read down through there. Some sites had tree cover, which might have affected the deposition of cesium. That was sufficient reason to be a type-B site. If gravel was encountered at the bottom of a sample, we felt that that was a less desirable site and became a type-B. Where it might be questionable that there might be areas of runoff, that made it a type-B site. Any site, even though it looked like it had a nice consistent vegetation, if it was not a lawn, that became automatically a type-B site. Some areas are indicated here as small. The small by itself was not a sufficient criterion to make it a type-B site; but small usually meant that it was not very far away from obstructions like buildings or trees. We have in this list indicated the reason why each site was designated as type-B as opposed to type-A.

As I mentioned, we had four sites that are questionable mainly because we feel uncomfortable with our present level of verification of the age.

Could I have the next viewgraph (LRA-52). Now this shows where all these sites are. This is kind of a complicated viewgraph. The code is up here (on upper right). The black indicates the DRI site selection as a preliminary candidate site. The blue is where Livermore actually made, or EG&G actually made in situ measurements. The green is where REECo made a soil sample collection. These dots are sites that have been selected for

laboratory analysis for cesium-137. Now you see we have some pretty good geographical coverage here. We do have some holes over in the area here in the region of some interesting areas in Nevada that we simply have not been able to locate sites which we feel comfortable with even on a B-level. So we are looking for some additional sites over in areas in Nevada. But, as you can see, we have extended our coverage now to a fairly good coverage of Arizona, northern Arizona, and we have extended our coverage in several areas here which were not originally tabulated by the Test Manager's Committee. We have some areas in Idaho where we believe there probably was some fairly substantial fallout deposition that are now included; and we have some areas here in Utah which we hope might help give us some additional information on how material got to Salt Lake City.

Now one of the tools we used that has been referred to before in this process was this book. Every member of the group had this book. Included in here is a photograph of the site, Frosty's site description, the results of the Livermore measurement, and also notes and maps; and I would hope that you might pick out your favorite site and actually come and look at this book--we will leave it up here--and perhaps get a feel for the type of information that was available to us when we made the site selection.

There is also shown up here a larger map, so that you can look at it without looking at the viewgraphs. We have several materials available, if you'd care to study this.

The next viewgraph (LRA-53). One of the recommendations of this Committee was that we provide a sufficient number of sites that we could make a comparison between our normal method of calculation of doses which is based upon external exposure rate measurements. This other method is based upon contemporary measurements of cesium in soil. So that these 10 sites are included in Phase II in order to make that comparison.

The next viewgraph (LRA-54) indicates that we have several communities with multiple sites. Now there's several different reasons why we have communities with multiple sites. In some cases, like Albuquerque is a good example, we do have some information that leads us to believe that there could be significant deposition from Nevada material in Albuquerque. So that we have included three sites, because it is a large town, so we can examine that question. Flagstaff, I think we have less reason to believe there is significant deposition there, but it is a large town which has three good sites. The other reason for doing this is to have a sufficient number of locations with two samples such that we can look at sample variability within the same location.

Now at some other sites, Boise is a good example, we had many areas which had the same cesium flux as measured with our field spectrometer, and one site which had essentially twice as much flux as any of the others. Unfortunately, that happened to be the State Capitol, so we thought we'd better make sure that we included that, measured both of the areas. Las Vegas is included, e.g., primarily because, again, it is a relatively large town. We want to look at two sites that are geographically separated within the same area.

That concludes my presentation, Mr. Chairman. Any questions?

DR. CAROTHERS: Lynn, have you, or has EML -- I'm sure they must have -- selected sites and taken a sample or two where you would expect to find no NTS fallout at all?

DR. ANSPAUGH: We have not done that yet ourselves. I think EML has done quite a bit of work on that. We do intend to take some additional samples along the west coast of California to look at that.

DR. CAROTHERS: I was just wondering, because then if you did that when you got done certain assumptions ought to be checked in a way. Phil,

you wanted to say something?

MR. KREY: Yes. I'd just like to say that I think you have to be a little careful when you use those words. I don't think there's a site in the United States that received no NTS fallout at all.

DR. CAROTHERS: Oh, I understand that. I've been on the witness stand and been questioned about, how much is any.

MR. KREY: So we certainly have made collections all over the United States. I think Lynn is planning to take a collection on the west coast. We've just retrieved a sample in 1982, the end of 1982, on the east coast. Yes, there will be other samples around. I'm a little sensitive to that, Jim, and I didn't mean to be legalistic in that sense, but it becomes hard to define when you say a site that has no NTS fallout at all. I think, I'll just throw it out as a suggestion that might be worthy of some consideration, and it was the same question that the Steering Committee addressed many years ago, as to what area you go to before you say, "I'm no longer interested in the impact of NTS."

DR. CAROTHERS: Phil, I'll bet you Hawaii has very little NTS fallout, but I'll bet it's got global.

MR. KREY: I said the United States. Of course, Hawaii is part of the United States.

DR. CAROTHERS: It's part of the United States.

MR. KREY: But I happen to know that the University of Texas -- Martha Scott is an oceanographer, and she is befuddled with an enormous amount of what appears to be NTS fallout in the sediments in the middle of the Carribean Sea; so it gets around an awful lot. I think you just have to be -- you know, it's something to consider. I, personally, have some difficulties looking at the dose from NTS fallout in Albany, or in Birmingham, or somewhere like that. Certainly if you wanted to be careful

and scientifically precise you probably could, indeed, find fallout that occurred in practically every town in the United States.

DR. CAROTHERS: Well, no, I'm not trying to be legalistic either. I was only thinking. Certainly you would agree that there are some sites which have less NTS fallout than others, and that if you picked a likely one that had probably very little fallout, like Hawaii, and ran your procedures on it, and so forth; then you would be surprised if you found a lot of NTS fallout.

MR. KREY: Well, in 1969 and 1970, we did a global soil sampling for plutonium and plutonium isotopics, and that has been published. I can't remember whether we got a sample from Hawaii or not. We might have, but we certainly got them in Europe, Asia, Africa, and South America. You certainly can see different isotopic compositions based on the geographical and longitudinal characteristics. But for the DAAG and ORERP to consider their Charter, I think you have to consider just the NTS.

DR. CAROTHERS: Well, I was thinking only of it as giving me confidence in your method. In a sense it's a blank, if you like, of a particular kind.

MR. KREY: Well, I hope I answered your question. We will have samples of that nature.

DR. CAROTHERS: Thank you.

CHAIRMAN MOSELEY: Other questions? Thank you very much, Lynn.

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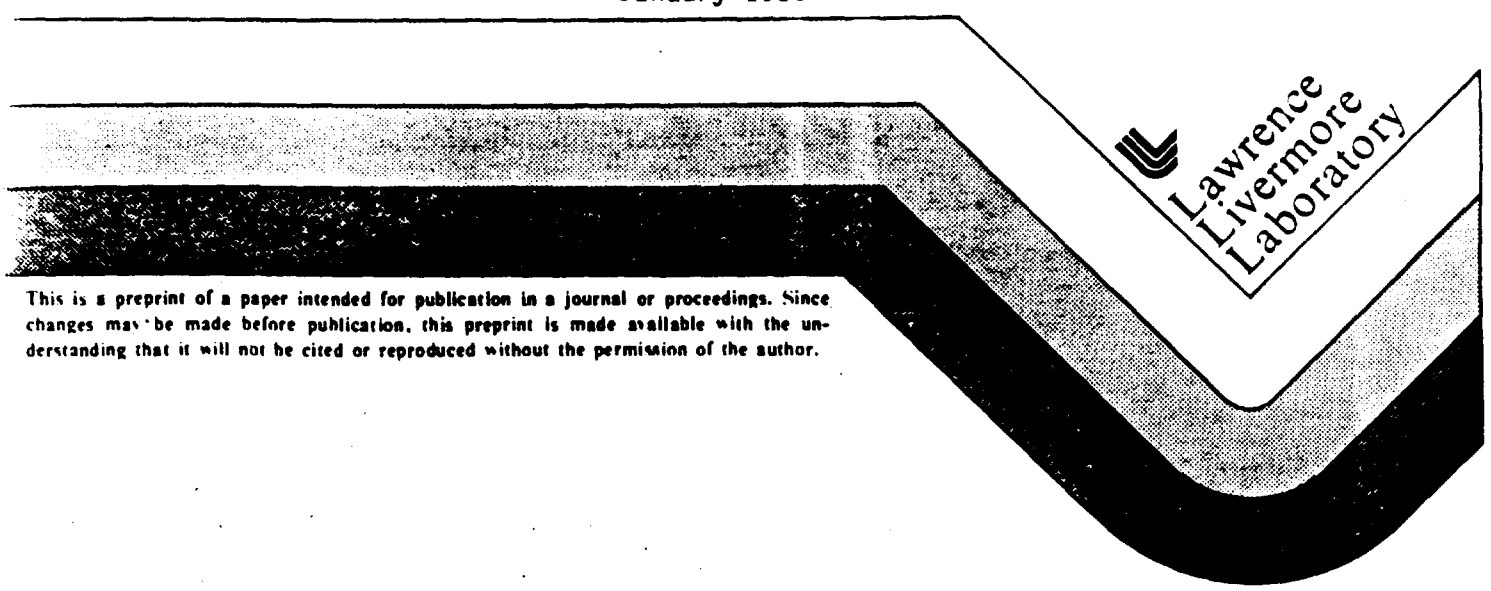
I. TEST SERIES THROUGH HARDTACK II, 1958

Lynn R. Anspaugh
Bruce W. Church

Health Physics

January 1983



HISTORICAL ESTIMATES OF EXPOSURE AND POPULATION EXPOSURE FROM TESTING AT THE NEVADA TEST SITE

I. TEST SERIES THROUGH HARDTACK II, 1958

Lynn R. Anspaugh

Environmental Sciences Division

Lawrence Livermore National Laboratory

University of California, Livermore, CA 94550

Bruce W. Church

Health Physics Division, Nevada Operations Office

Department of Energy, Las Vegas, NV 89114

ABSTRACT

Based upon estimates of population and calculations of estimated exposure made by the Test Manager's Committee to Establish Fallout Doses, we have tabulated the population estimated exposures for communities within established fallout patterns. The total population estimated exposure is 85,000 person-R. The greatest population exposures occurred in three general areas: Saint George, Utah; Ely, and Las Vegas, Nevada. Three events, HARRY (May 19, 1953), BEE (March 22, 1955), and SMOKY (August 31, 1957), accounted for over half of the total population estimated exposure. The bases of the calculational models for "infinite exposure," "estimated exposure," and "one year effective biological exposure" are explained.

INTRODUCTION

We and individuals from several other organizations are engaged in a major, 4-yr project that has the goal of determining the radiation doses received by residents in the region of the Nevada Test Site (NTS). This complete evaluation will include doses received from external gamma and beta exposure due to the fallout field, from external gamma and beta exposure from immersion in the debris clouds, from beta exposure of the skin from direct deposition of fallout, and from internal exposure due to the intake of radionuclides via inhalation and ingestion. All activities conducted at the NTS will be included. It is not generally appreciated that tests of nuclear engines and ramjets were conducted at the NTS during the 1959 to 1969 period, and that these reactor tests released radionuclides to offsite locations.

One of the important goals of this project is to understand the measurements that were made in the field at the times immediately following the detonations, and the methods of calculation that were used to translate these measurements into estimates of exposure and/or dose. Unfortunately, there was no major effort to calculate the dose that people received from internal emitters and this is a major part of our study. Some radionuclides, such as ^{90}Sr, ^{131}I, and ^{137}Cs, did receive major attention as time went on (JCAE63), but the available measurement techniques and assessment methods did not permit a complete evaluation.

In contrast, a great deal of effort was devoted to calculating the external gamma exposure received by the off-site residents. The most substantial of these efforts was undertaken by the Test Manager's Committee to Establish Fallout Doses (TMCEFD). This committee was chaired by A. Vay Shelton of the University of California Radiation Laboratory (now Lawrence Livermore National Laboratory) and included Roscoe H. Goeke, US Public Health Service (PHS), William R. Kennedy, Los Alamos Scientific Laboratory, Kermit H. Larson, UCLA, Kenneth M. Nagler, US Weather Bureau, and Oliver R. Placak, USPHS. This Committee's major report was completed in 1959 (Sh59) and covered testing conducted up through 1958, but the report was not widely distributed nor formally published. The results, however, were summarized in a paper by Dunning (Du59) published in the 1959 Hearings on Fallout from Nuclear Weapons Tests conducted by the Joint Committee on Atomic Energy (JCAE). These documents provided estimates of exposure for 300 localities that were judged to be "within the fallout region."

A controversy has arisen over these exposure estimates (Sh59 and Du59 refer to estimates of "dose," but they clearly are estimates of exposure as we use the terms today); much of this controversy (e.g., Hu79) results from an alleged discrepancy between results reported by the Atomic Energy Commission (AEC), a predecessor agency of the Department of Energy, and the PHS. It is our opinion that this controversy is due entirely to a misunderstanding of the terms and methods used by the TMCEFD (Sh59) and the PHS (e.g., PHS55).

There are several purposes for this paper. First, we will explain the methods used by the TMCEFD in deriving their estimates; we believe these are the best estimates available at present because they were

made by people who had intimate and current knowledge of the original measurements. Second, we will use these estimates to calculate population exposure by communities; we hope such data may be useful to epidemiologists. A third purpose is to identify those locations that received the largest population exposures and those weapons tests that produced the largest population exposures. A subsequent paper will address the population exposures that have resulted from NTS-related activities after the Hardtack II test series ended in 1958.

Shleien (Sh181) recently published his estimates of population exposure for activities at the NTS between 1951 and 1970. His results are based upon a different calculational model and he did not include several exposed communities that were included in the TMCEFD tabulation.

METHODS

About half of the population exposure during the 1951 to 1958 period was due to the UPSHOT-KNOTHOLE series in 1953. It is important to note that during this series only very few measurements of <u>exposure</u> were made by the use of film badges or other integrating devices. Rather, measurements of open-field external exposure <u>rate</u> were made and a calculational model was necessary to convert to estimates of human exposure. External exposure rates were typically measured with the AN/PDR-T1B ionization-chamber instrument when the rates were >10 mR/hr or the MX-5 Geiger-Mueller tube instrument when rates were <10 mR/hr. Because readings were made at many times post detonation when the external exposure rate was changing rapidly with time, it was desirable to normalize to a common time in order to construct isopleths. The

convention was adopted frequently that the exposure rate from material deposited at a given location varies with time according to the relationship

$$R(t) = R(1)\, t^{-1.2} \qquad [1]$$

where $R(t)$ = Exposure rate at time t in hr, and

$R(1)$ = Exposure rate at 1 hr.

This has become known as the $t^{-1.2}$ "law," but the relationship was originally derived as an approximation (Wa48) of the rate of decay of fission-product beta activity. It is instructive to note that Way and Wigner (Wa48) actually calculated two quantities: the rate of beta-particle emission as a function of time, $\beta(t)$, and the rate of total energy emission as a function of time, $3B(t) + \Gamma(t)$; where $B(t)$ is the rate of total beta-energy emission and $\Gamma(t)$ is the rate of total gamma-energy emission. Neither of these quantities is an appropriate analog of the external gamma-exposure rate for the resulting fallout field, but presumably the rate of total energy emission would be the better analog. The results of Way and Wigner's calculations for $t < 1$ sec are

$$\beta(t) = \sim (0.38 - 2.6t) \text{ /sec} \qquad [2]$$

$$\text{and } 3B(t) + \Gamma(t) = \sim (3.8 - 0.61t) \text{ MeV/sec} \qquad [3]$$

For times longer than one day, the results are

$$\beta(t) = \sim 5.2 \times 10^{-6}\ d^{-1.2}\ /\text{sec} \qquad [4]$$

$$\text{and } 3B(t) + \Gamma(t) = \sim (3.9\ d^{-1.2} + 11.7\ d^{-1.4}) \times 10^{-6}\ \text{MeV/sec.} \qquad [5]$$

These results, which apparently are the source of the $t^{-1.2}$ "law," suggest that there should not be a simple power-law dependence of the external gamma-exposure rate as a function of time and that $t^{-1.4}$ might have been a better "law" over longer times. Nevertheless, the $t^{-1.2}$ approximation was frequently used to describe the decrease with time of the external gamma-exposure rate. As an approximation, it was then a natural extension to calculate an infinite exposure (IE) as

$$IE = R(1)\int_a^\infty t^{-1.2}dt = \frac{R(1)}{-0.2}\left[t^{-0.2}\right]_a^\infty = 5R(1)a^{-0.2} \qquad [6]$$

where a is the time of arrival. In such a calculation, the validity of the $t^{-1.2}$ approximation is of major importance. If, for example, a more appropriate model were $t^{-1.4}$, the infinite exposure would be $R(1)a^{-0.4}/0.4$. For an arrival time of 3 hr, the two models differ by a factor of 4.0/1.6 or 2.5.

Recent analysis of the original data taken following the weapons test HARRY (May 19, 1953) indicates that a more appropriate model of the rate of decrease of the external gamma exposure rate is $t^{-1.35}$ over periods of about 100 hr (Qu81). Hicks (Hi82) has also performed detailed calculations of the expected rate of decay of the HARRY and

SMOKY external gamma-exposure fields based upon the individual radionuclides and their gamma emissions, and has shown that $t^{-1.35}$ is a better approximation over longer time periods.

Also, the use of this infinite exposure model does not represent realistically the exposure received by people because no provision is made for the shielding provided by residences, workplaces, schools, or automobiles.

These two problems were recognized and addressed by Dunning (Du57a,b). Based upon measurements of the external gamma-exposure field on the Island of Rongelap over a two-yr period (reproduced in Fig. 1), Dunning developed the following model as a more realistic expression of the external exposure rate in a real open-field situation where fallout is weathering into soil:

$$R(t) = \begin{cases} R(1)\ t^{-1.2} & \text{for } t < 168 \text{ hr} \\ bR(1)\ t^{-1.3} & \text{for } 168 \text{ hr} < t < 336 \text{ hr} \\ cR(1)\ t^{-1.4} & \text{for } 336 \text{ hr} \leq t \end{cases} \qquad [7]$$

where b and c are constants required for continuity.

The estimated exposure (EE) experienced by people over a one-yr period is then calculated as

$$EE = S \int_a^{8760} R(t)\, dt \qquad [8]$$

where S is a building shielding factor of 0.75. This was based upon the experimental observation that buildings reduce exposure by an average factor of two (Du57a) and the assumption that people are in buildings half the time. The solution of the above is

$$EE = 0.75\, R(1) \left[\frac{1}{0.2} \left(a^{-0.2} - 168^{-0.2}\right) + \frac{168^{0.1}}{0.3} \left(168^{-0.3} - 336^{-0.3}\right) + \frac{2^{0.1}\ 168^{0.2}}{0.4} \left(336^{-0.4} - 8760^{-0.4}\right) \right] \qquad [9]$$

Dunning (Du56, AEC57) also developed the concept of the one-year effective biological exposure (EBE). (Both estimated exposure and effective biological exposure were referred to as "doses," but were calculated in units of R. For consistency, we will refer to both as "exposure.") This was done in order to account for the concept of biological repair and was intended only for application where acute somatic effects were of concern. The defining differential equation for EBE is

$$\frac{d(EBE)}{dt} = S \cdot R(t) - \lambda(EBE) \qquad [10]$$

where $R(t)$ is given by Eq. [7] and λ is a repair constant equal to $\ell n 2/672$ hr. There is no easy solution of Eq. 10, but a graphical solution has been provided (AEC57).

A comparison of the three calculational models is shown in Table 1 for several different times of arrival of fallout. For most arrival times of interest, the EE is shown to be roughly half of the IE.

For its estimates of exposure, the TMCEFD used the calculational model of estimated exposure for the BUSTER-JANGLE (1951), TUMBLER-SNAPPER (1952), UPSHOT-KNOTHOLE (1953), and TEAPOT (1955) series. The

TMCEFD said and thought they were using the effective biological exposure model (Sh59). However, one of their input papers prepared by Nagler and Telegadas (Na56) contains a table of conversions from infinite exposure; this is reproduced in Table 2. A comparison of Tables 1 and 2 demonstrates that they were indeed using the estimated exposure model. Further, Nagler and Telegadas stated that the data reproduced in Table 2 were supplied by Dunning and he (Du81) has confirmed that the relevant model was indeed that of estimated exposure.

For the PLUMBBOB (1957) series, an alternate approach was used by the TMCEFD. Larson et al. (La59) collected many samples of PLUMBBOB fallout, returned them to the laboratory, and measured the rate of decay of gamma emissions. From these data, they constructed a composite PLUMBBOB gamma-decay curve and the TMCEFD used these data in place of Eq. [7]. They did not appreciate that the rate of gamma emission is not adequate directly as a model for external exposure rate, as the energy per gamma emitted changes with time, and there is no indication that their data were corrected for the efficiency of the detector as a function of energy. The TMCEFD, Sh59, state that the PLUMBBOB data so calculated were about 50% higher than would have been calculated with the infinite exposure model. In terms of the estimated exposure model, we conclude that the PLUMBBOB estimates are too high by about 100%. For PLUMBBOB, the TMCEFD also used film badge data to estimate exposure for some communities. As the film badges were not in the field for a full year, they used a rough model of multiplying the film badge reading by 1.3 to approximate infinite exposure and then dividing by 2 to approximate estimated exposure.

For the HARDTACK II (1958) series, the exposures to communities were all small and much less effort was devoted to estimating exposures. In general, most of the estimates of exposure to communities were based upon film badge data with no corrections applied.

It is also important to note that during the earlier test series (prior to PLUMBBOB), no radiation surveys were made in some communities. In order to assess exposures for such communities, the TMCEFD constructed exposure isopleths and interpolated between these isopleths.

The TMCEFD report (Sh59) itself contains data for the 300 communities aggregated by "Pre-PLUMBBOB," "PLUMBBOB," "HARDTACK II," and "Cumulative." Through the courtesy of the late Mr. Kosta Telegadas, we have access to the original compilations for the TMCEFD of estimated exposures by individual weapons tests. We have used these data to calculate population, or collective, estimated exposure. The population data were also taken from Sh59, wherein many population figures were listed as ranges over the total time period or were listed as "not available," "transient," or "variable." Where ranges were provided, we used the higher number in our calculations of population exposure. Where the population was listed as "not available" or "transient," we have not included these locations in population exposure tabulations, but list them separately with the cumulative estimated exposures. Where the population was listed as "variable," footnotes were frequently provided that contained sufficient information to calculate population exposures; if not, they were treated as locations of unknown population.

RESULTS

The calculated values of cumulative population estimated exposure by communities within the States of Arizona, California, Nevada, and Utah are listed in Table 3. The cumulative estimated exposures for locations where no population figures were listed are also provided in Table 3. This Table, including the footnotes, lists all of the locations for which the TMCEFD estimated exposures. Of these many communities, only 19 received cumulative population estimated exposures in excess of 1,000 person-R, and they account for 76% of the total cumulative population estimated exposure. Details for these 19 communities are provided in Table 4.

The total cumulative population estimated exposure by test series is shown in Table 5.

Table 6 presents the population estimated exposure for the 17 individual events that contributed more than 1,000 person-R. (The HARDTACK II series is listed as a single event because the series was analyzed in entirety by use of film badge data.) These 17 events contributed more than 90% of the total population estimated exposure.

Tables 3 through 6 all contain data calculated with the use of the original materials of the TMCEFD. Where we believe their results are in error, this has been noted in footnotes to these Tables.

DISCUSSION

Table 5 indicates that the population estimated exposure from all of the tests through the end of 1958 totaled 85,000 person-R. This can

be converted to a bone-marrow population dose of 59,000 person-rad by use of an absorbed dose/exposure factor of 0.7 rad/R (As79).

The TMCEFD inexplicably did not include Reno, Nevada, in its tabulation. Apparently, the only exposure in Reno was from event BOLTZMANN of the PLUMBBOB series. According to the PHS report (P157), the estimated exposure at Reno was 45 mR and the population was 35,000 people. This population estimated exposure of 1600 person-R would rank tenth in terms of total community exposure.

As noted above, we believe that the TMCEFD overestimated the estimated exposures for the PLUMBBOB series by a factor of two. By making this correction and including the exposure at Reno from event BOLTZMANN, we calculate a corrected population estimated exposure of 19,000/2 person-R + 35,000 persons x 0.045 R = 11,000 person-R for the PLUMBBOB series.

For the HARDTACK II series, the calculated population exposures are small and all of the community estimated exposures were less than or equal to 150 mR with the exception of Adam's Ranch, Nevada, which received 800 mR. As these values were evidently not corrected for background radiation, the TMCEFD values are perhaps too high by a factor of about 2.

Saint George, Utah, received the largest community population estimated exposure of 18,000 person-R and also had a relatively high cumulative estimated exposure of 3.7 R. Other communities in the same area were Hurricane, Washington, La Verkin, and Santa Clara and these also received relatively high exposures as shown in Table 4. The communities of Ely, McGill, East Ely, and Ruth, Nevada, are similarly located close together and represent another area of relatively large

population estimated exposure. Las Vegas, Nevada, had the second highest population estimated exposure but the estimated exposure was quite low at 0.21 R. Most of this estimated exposure, 0.17 R, was due to event BEE.

Only a few events accounted for most of the population estimated exposure. The data in Table 6 show that event HARRY resulted in 30,000 person-R; this is 35% of the total cumulative population estimated exposure. The three events, HARRY, BEE, and SMOKY, accounted for 57% of the total cumulative population estimated exposure.

The TMCEFD (Sh59) also attempted to estimate the uncertainties associated with their calculations. They considered these sources of uncertainty: 1) Fission-product decay rate, 2) Instrument response to the mixed fission-product field as compared to calibration source, 3) Inaccuracy of instrument readings at lower exposure rates, 4) The use of film badge data in the calculations as opposed to exposure-rate measurements, 5) Analysis or interpolation to derive results for communities where no exposure-rate measurements were made, and 6) Uneven deposition of fallout. Their estimates of the cumulative uncertainty factors were

± 80% for < 0.1 R,

± 60% for 0.1 to 1.0 R, and

± 40% for > 1.0 R.

Recently, Krey and Beck (Kr81) have measured the total areal deposition of ^{137}Cs and $^{239,240}Pu$ for soils in Utah, and have also determined the ratio $^{240}Pu/^{239}Pu$. Because this ratio is different

for NTS and global fallout, they have been able to determine the amounts of NTS-derived ^{137}Cs in soil. They (Be82) then calculated the short-lived fission products that would have accompanied the ^{137}Cs from NTS and the resulting infinite exposure. A comparison of their results and the TMCEFD results is shown in Table 7 for all communities where data from both sources are available. The two sets of results, based upon independent methods, agree well.

The TMCEFD did not calculate estimated exposures at distances as far away as Salt Lake City, Utah, and fallout patterns were not plotted to such distances, in general. Data in Be82 indicate that the cumulative infinite exposure at Salt Lake City might have been 1.2 R and the cumulative population infinite exposure might have been 220,000 person-R; the cumulative estimated exposure and the cumulative population estimated exposure would be approximately half of these amounts. The latter is larger than the total population estimated exposure shown in Table 5 for all of the closer in communities that are considered to be in the "high fallout" region.

Because the raw data that served as input to calculations in this paper have not been generally available to the scientific community, we have prepared a companion report (An82) that contains these data and a reproduction of the TMCEFD report.

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CAPTIONS LIST

Fig. 1. The measured external exposure rate over long time periods compared to that predicted by $t^{-1.2}$, and an early attempt to calculate the rate based upon nuclide composition. Redrawn from Du57b.

Table 1. A comparison of the three calculational models: infinite exposure (IE), estimated exposure (EE), and effective biological exposure (EBE). Results are expressed as reduction factors compared to an infinite exposure of 1.0 at all times of arrival.

Table 2. Calculational model used by Nagler and Telegadas (Na56) to calculate estimated exposure. The original reference mistakenly referred to the calculation as effective biological exposure.

Table 3. Cumulative estimated exposure in R and cumulative population estimated exposure in person-R by community from weapons tests at the Nevada Test Site, 1951 to 1958. A dash indicates that the population was unknown, transient, or variable.

Table 4. Population, cumulative estimated exposure, and cumulative population estimated exposure, for the 19 communities receiving a cumulative population estimated exposure in excess of 1,000 person-R during 1951-1958.

Table 5. Cumulative population estimated exposure by test series.

Table 6. Cumulative population estimated exposure for the 17 events that contributed more than 1000 person-R, 1951-1958.

Table 7. Comparison of the recent results of Beck and Krey (Be82) based on contemporary measurements of ^{137}Cs with those of the TMCEFD.

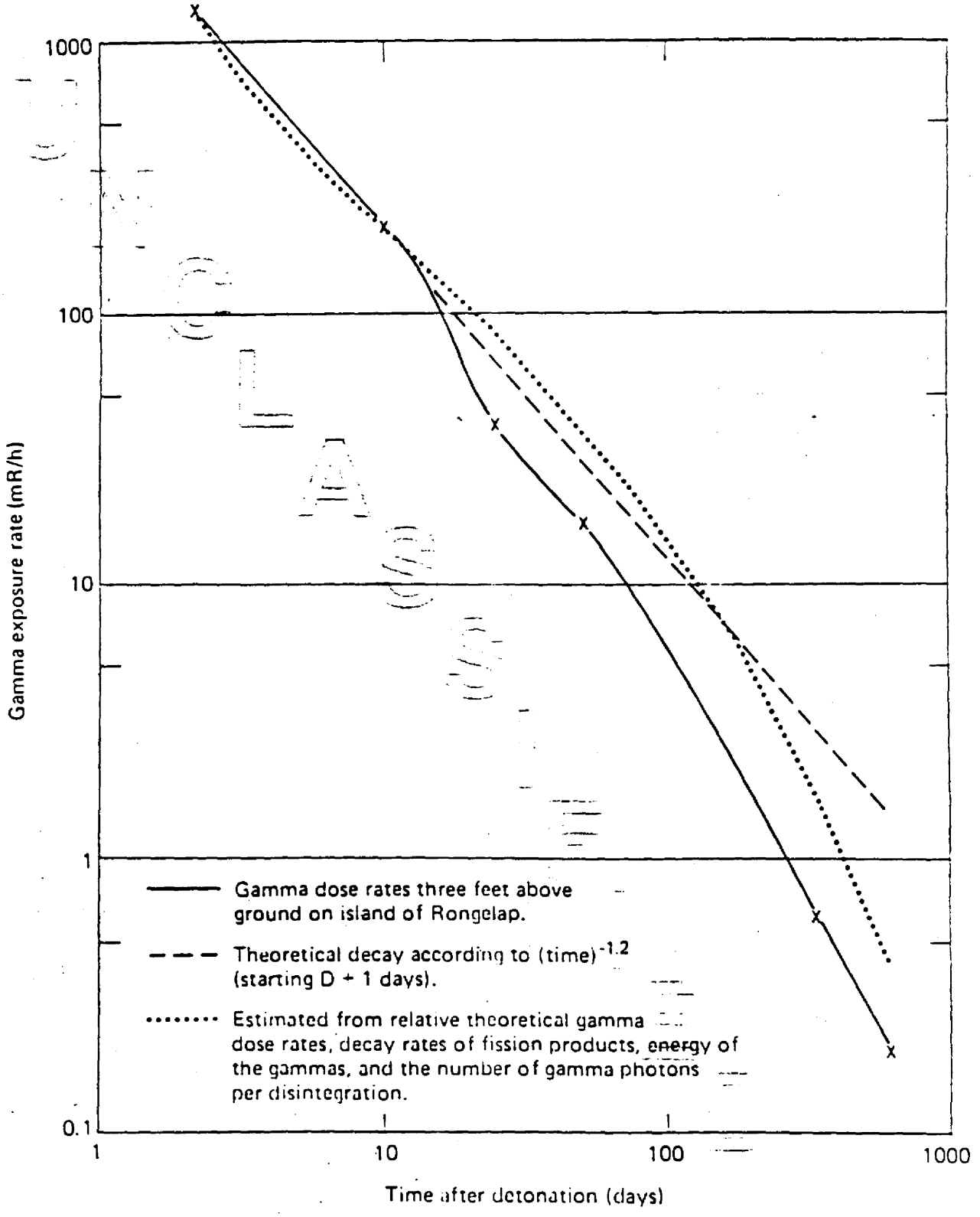

1000
100
10
1
0.1
Gamma exposure rate (mR/h)
1
10
100
1000
Time after detonation (days)
Gamma dose rates three feet above ground on island of Rongelap.
Theoretical decay according to (time)$^{-1.2}$ (starting D + 1 days).
Estimated from relative theoretical gamma dose rates, decay rates of fission products, energy of the gammas, and the number of gamma photons per disintegration.

Table 1. A comparison of the three calculational models: infinite exposure (IE), estimated exposure (EE), and effective biological exposure (EBE). Results are expressed as reduction factors compared to an infinite exposure of 1.0 at all times of arrival.

Time of arrival, hr	Shielding	x Weathering[a]	x Time[b]	= EE	x Repair	= EBE
1	0.75	0.83	0.95	0.59	0.84	0.50
2	0.75	0.81	0.94	0.57	0.81	0.46
3	0.75	0.79	0.94	0.56	0.79	0.44
4	0.75	0.78	0.93	0.54	0.79	0.43
6	0.75	0.76	0.93	0.53	0.78	0.41
8	0.75	0.75	0.92	0.51	0.76	0.39
10	0.75	0.73	0.91	0.50	0.76	0.38
12	0.75	0.72	0.91	0.49	0.75	0.37
14	0.75	0.71	0.91	0.49	0.74	0.36
16	0.75	0.71	0.90	0.48	0.73	0.35
18	0.75	0.70	0.90	0.47	0.73	0.35
20	0.75	0.69	0.90	0.47	0.73	0.34

[a]"Weathering" includes the effects of variation from $t^{-1.2}$ in decay rate of the external exposure rate and the variation in shielding or "ground roughness" effects as fallout weathers into the soil. The calculations are based upon an empirical model.

[b]The effect of integrating for one yr instead of infinite time.

Table 2. Calculational model used by Nagler and Telegadas (Na56) to calculate estimated exposure. The original reference mistakenly referred to the calculation as effective biological exposure.

Time of arrival, hr	Percent of infinite exposure
0.5 - 0.8	60
0.9 - 1.2	59
1.3 - 1.7	58
1.8 - 2.3	57
2.4 - 2.9	56
3.0 - 3.6	55
3.7 - 4.3	54
4.4 - 5.3	53
5.4 - 6.4	52
6.5 - 7.7	51
7.8 - 9.4	50
9.5 - 11.5	49
11.6 - 14.0	48
14.1 - 17.2	47
17.3 - 20.6	46
20.7 - 24.3	45
24.4 - 30.	44

Table 3. Cumulative estimated exposure in R and cumulative population estimated exposure in person-R by community from weapons tests at the Nevada Test Site, 1951 to 1958. A dash indicates that the population was unknown, transient, or variable.

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
		Arizona[a]			
Beaver Dam	2.3	12.	Kingman	0.04	220
Big Bend Ranch	2.2	11.	Lake Mohave	0.02	0.04
Bullhead	0.02	10.	Littlefield	1.9	84.
Chloride	0.02	3.2	Mount Trumbull	0.16	16.
Grasshopper Junction	0.03	0.06	Short Creek	1.6	140.
Hackberry	0.01	1.0	Valentine	0.01	0.50
Hughes Ranch	2.3	--	Wolf Hole	1.3	6.5
		California[b]			
Baker	0.03	22.	Johannesburg	0.03	9.0
Barstow	0.01	100.	Kelso	0.03	8.1
Benton Station	0.07	21.	Laws	0.07	5.0
Big Pine	0.03	17.	Lenwood	0.01	26.
Bishop	0.06	170.	Lone Pine	0.08	110.
Cartago	0.03	3.8	Oasis	0.10	1.2
Chalfant	0.10	2.5	Olancha	0.03	8.2
Death Valley Junction	0.15	3.0	Red Mountain	0.03	9.6
Deep Spings	0.03	3.0	Ridgecrest	0.02	80.
Emigrant Springs Ranger Station	0.09	0.18	Ryan Mine	0.21	0.21
			Silver Lake	0.05	0.50
Essex	0.02	1.5	Stovepipe Wells	0.06	0.12
Furnace Creek	0.15	7.5	Tom's Place	0.02	--
Independence	0.02	18.	Yermo	0.01	7.0

Table 3. (continued)

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
		Nevada[c,d,e]			
A & B Mine	3.4	41.	Cactus Springs	0.08	1.4
Acoma	3.0	30	Caliente	0.76	740.
Adam's Ranch	2.2	--	Carp	3.9	98.
Alamo	1.4	350.	Caselton Mine	0.72	110.
Apex	0.13	6.5	Charleston Lodge	0.01	0.60
Ash Meadows	0.21	1.7	Cherry Creek	0.50	56.
Ash Springs	0.66	3.3	Clark's Station	1.6	8.0
Atlanta	0.56	1.1	Cloud	3.6	--
Austin	0.20	100.	Coaldale	0.98	24.
Babbitt	0.28	690.	Cole & Dolan Ranch	0.81	2.4
Baker	1.0	63.	Corn Creek	0.40	4.4
Barclay	2.0	20.	Cove	0.85	17.
Bardoli Ranch	2.0	7.9	Crestline	0.70	15.
Basalt	0.20	1.6	Crystal	4.1	20.
Beatty	0.21	110.	Currant	0.83	62.
Belew Ranch	1.7	5.2	Delmue	0.65	4.6
Belmont	1.2	7.5	Desert Rock	0.19	--
Blue Diamond	0.05	20.	Dodge Const. Camp	11.	470
Blue Eagle School	1.6	17.	Donahue Ranch	0.35	1.4
Bonanza Boy Scout Camp	0.12	--	Dry Lake	1.0	21.
Bond Ranch	0.75	--	Duckwater	1.0	50.
Boulder City	0.08	320.	D-X Ranch	1.0	--
Boyd	1.5	--	Dyer	0.18	6.3
Bristol Silver Mine	0.78	39.	East Ely	1.2	1200.
Buckhorn Ranch	0.98	12.	El Dorado	1.0	3.2
Bunkerville	4.5	1100.	Eldridge Ranch		
Butler Ranch	15.	30.	(Mt. Wheeler Inn)	0.98	--

Table 3. (continued)

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
		Nevada (continued)			
Eldridge Ranch	0.54	2.2	Kimberly	0.92	110.
Elgin	3.6	110.	Kyle	3.5	--
Ely	1.2	4300.	Laboard Ranch	0.45	--
Etna	0.82	--	Lake Mead Base	0.09	0.45
Eureka	0.85	420.	Lane City	0.98	39.
Fallini Ranch	2.0	30.	Las Vegas	0.21	9900
Fallon	0.14	340.	Lathrop Wells	0.16	2.4
Fish Creek Ranch	1.2	--	Lehman Caves	1.2	--
Gabbs	0.38	240.	Leith	3.3	--
Galt	11.	--	Lida	0.87	22.
Garnet	0.90	--	Lida Junction	1.3	3.8
Geyser Maint. Station	1.4	14.	Lincoln Mine	6.0	3000.
Geyser Ranch	1.6	7.8	Lockes	1.6	6.4
Glendale	0.85	64.	Logandale	0.56	170.
Goldfield	1.2	260.	Lund	1.3	320.
Goldpoint	1.3	13.	Luning	0.49	24.
Groom Mine	4.9	20.	M & M Mine	3.4	6.8
Gubler Ranch	1.4	--	Manhattan	0.39	16.
Hawthorne	0.28	520.	McGill	0.77	1800
Henderson	0.02	280.	Mercury	0.22	770.
Hiko	1.1	59.	Mesquite	2.1	1200.
Hollinger's Ranch	0.37	0.37	Millett	0.44	2.2
Hoover Dam	0.05	--	Mina	0.58	260.
Hoya	5.9	--	Moapa	0.77	40.
Indian Creek Ranch	0.98	--	Moapa Indian Res.	0.79	120.
Indian Springs	0.15	280.	Moon River Ranch	2.1	6.2
Ione	0.24	9.6	Mounts Ranch	1.1	--

Table 3. (continued)

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
		Nevada (continued)			
Nellis AFB	0.05	400.	Schurz	0.22	22.
Nivloc	0.43	110.	Searchlight	0.08	12.
North Las Vegas	0.20	2600.	Searls Ranch	0.98	16.
Nyala	2.1	12.	Seven L Ranch	0.42	0.42
Overton	0.43	320.	Sharps (Adaven)	1.7	42.
Pahrump	0.20	18.	Shoshone	0.94	240.
Pahrump Mining Co.	0.10	--	Silver Peak	0.75	5.2
Panaca	0.66	330.	South Paw Mine	1.8	5.5
Parmon's Ranch	0.45	3.6	Springdale	0.11	1.6
Pioche	0.74	1000.	Steward, R. Ranch	1.3	7.8
Pittman	0.10	--	Stine	1.2	--
Pony Springs	1.2	--	Stone Cabin Ranch	1.0	8.2
Potts	0.39	6.6	Sunnyside	1.7	45.
Preston	1.2	74.	Swallow Ranch	1.0	--
Rattlesnake Maint. Station	1.6	6.6	Tonopah	1.1	1500.
Reed	6.7	11.	Tonopah Airport	0.80	3.2
Reville Mill	5.5	29.	Uhalde Ranch	1.9	15.
Phyolite	0.11	0.77	Urretias Ranch	1.8	--
Riverside	8.0	110.	Ursine	0.61	15.
Rogers Ranch	0.31	3.1	Vigo	3.5	--
Rose Valley	0.65	6.5	Walch Pine Creek Ranch	2.8	17.
Round Mountain	0.49	98.	Warm Springs	0.93	51.
Rox	3.3	--	Warm Springs Ranch	1.2	580.
Ruby Hill Mine	0.88	44.	Watertown	3.8	15.
Ruth	0.95	1200	Whipple Ranch	1.1	11.
Sarcobatus	0.23	0.69			

Table 3. (continued)

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
			Utah		
Adamsville	0.23	22.	Kanab	1.6	3100.
Alton	0.83	130.	Kanarraville	1.9	510.
Anderson Junction	1.9	32.	Kanosh	0.05	24.
Bear Valley Junction	0.95	9.5	La Verkin	3.7	1400.
Beaver	0.25	420.	Leeds	3.7	800.
Beryl	0.53	8.0	Long Valley Junction	0.87	8.7
Bery Junction	1.0	8.4	Lund	0.50	38.
Black Rock	0.05	0.45	Manderfield	0.23	14.
Bryce Canyon	0.56	--	Milford	0.10	170.
Cedar City	0.64	3900.	Minersville	0.20	120.
Central	1.9	94.	Modena	0.54	54.
Cove Fort	0.07	0.56	Mount Carmel	0.94	120.
Desert Range Exp. Sta.	0.10	0.50	Mount Carmel Junction	0.85	8.5
Duck Creek Forest Camp	1.1	--	Newcastle	0.65	75.
Enoch	0.54	140.	New Harmony	1.9	240.
Enterprise	0.79	630.	Orderville	1.6	590.
Garrison	0.88	110.	Paiute Indian Res.	0.30	28.
Glendale	1.4	380.	Panguitch	0.70	1000.
Greenville	0.24	42.	Paragonah	0.42	170.
Gunlock	3.1	400.	Parowan	0.42	610.
Hamilton Fort	0.80	21.	Pintura	2.2	110.
Hamlin Valley	0.51	--	Rockville	3.1	390.
Hatch	0.54	13.	Saint George	3.7	18,000
Hilldale	0.44	4.4	Santa Clara	4.3	1,400.
Hurricane	3.5	4800.	Shivwits	3.6	340.

Table 3. (continued)

Community	Cumulative exposure	Cumulative population exposure	Community	Cumulative exposure	Cumulative population exposure
			Utah (continued)		
Springdale	2.7	560.	Vic's Service Station	3.9	7.8
Summit	0.52	76.	Virgin	1.6	240.
Toquerville	2.3	510.	Washington	3.3	1,400.
Uvada	0.70	10.	Zane	0.30	7.5
Veyo	2.8	280.	Zion Lodge	1.2	--
Vic's Place	1.9	5.6			

[a]Fallout was not distinguished from background radiation at these Arizona communities: Catherine Ranger Station, Davis Dam, Oatman, Peach Spring, Topock, Truxton, Walapai, Warm Springs, Willow Beach, and Yucca.

[b]Fallout was not distinguished from background radiation at these California communities: Amboy, Boron, Camp Irwin, Cantil, China Lake, Crest View, Daggett, Hinkley, Inyokern, Littlelake, Ludlow, Manix, Mojave, Mountain Pass, Needles, Newberry, Randsburg, Shoshone, South Haiwee, Tecopa, Trona, Wheaten Springs, and ZZXYZ Springs.

[c]Fallout was not distinguished from background radiation at these Nevada communities: Goodsprings, Johnnie, Nelson, Pop's Oasis, State Line, and Whitney.

[d]Reno was not included in the TMCEFD tabulations. We calculated a population estimated exposure of 1600 person-R from event BOLTZMANN.

[e]Boyd, Cloud, Etna, Galt, Garnet, Hoya, Kyle, Leith, Rox, Stine, and Vigo were railroad maintenance stations. Apparently a crew of 15 people moved from station to station.

Table 4. Population, cumulative estimated exposure, and cumulative population estimated exposure, for the 19 communities receiving a cumulative population estimated exposure in excess of 1,000 person-R during 1951-1958.

Location[a]	Population	Cumulative estimated exposure, R	Cumulative population estimated exposure, person-R
Saint George, UT	5,000	3.7	18,000
Las Vegas, NV	47,000	0.21	9,900
Hurricane, UT	1,375	3.5	4,800
Ely, NV	3,558	1.2	4,300
Cedar City, UT	6,106	0.64	3,900
Kanab, UT	1,900	1.6	3,100
Lincoln Mine, NV	100 to 500	6.0	3,000[b]
North Las Vegas, NV	13,000	0.20	2,600
McGill, NV	2,297	0.77	1,800
Tonopah, NV	1,375	1.1	1,500
Washington, UT	435	3.3	1,400
La Verkin, UT	387	3.7	1,400
Santa Clara, UT	319	4.3	1,400
Mesquite, NV	590	2.1	1,200
East Ely, NV	1,000	1.2	1,200
Ruth, NV	1,244	0.95	1,200
Bunkerville, NV	250	4.5	1,100
Panguitch, UT	1,500	0.70	1,000
Pioche, NV	1,392	0.74	1,000
Total	89,228[b]		64,000[b]

[a]Reno, NV, according to our calculation, received a population estimated exposure of 1600 person-R and would therefore rank tenth in population estimated exposure.

[b]Calculated by using a population of 500 at Lincoln Mine.

Table 5. Cumulative population estimated exposure by test series.

Series	Year	Person-R
BUSTER-JANGLE	1951	610
TUMBLER-SNAPPER	1952	4,700
UPSHOT-KNOTHOLE	1953	40,000
TEAPOT	1955	19,000
PLUMBBOB	1957	19,000[a]
HARDTACK II	1958	1,500
Total		85,000

[a]Because of the use of what we now believe to be an inappropriate model for the rate of decay of the external exposure field and the neglect of the exposure at Reno, NV, we believe that this value is incorrect. Our estimate is 11,000 person-R.

Table 6. Cumulative population estimated exposure for the 17 events that contributed more than 1000 person-R, 1951-1958.

Event[a]	Date	Population estimated exposure, person-R
HARRY	530519	30,000
BEE	550322	11,000
SMOKY	570831	7,500
ANNIE	530317	3,700
EASY	520507	2,700
DIABLO	570715	2,700
SHASTA	570818	2,600
ZUCCHINI	550515	2,300
SIMON	530425	2,200
BADGER	530418	2,100
NANCY	530324	1,800
FOX	520525	1,800
APPLE II	550505	1,700
HARDTACK II Series	1958	1,500
KEPLER	570724	1,500
WHITNEY	570923	1,300
MET	550415	1,200
Total		77,000

[a]If we include 1600 person-R at Reno, NV, the total for event BOLTZMANN would be 2200 person-R. This event would then rank tenth in the above tabulation.

Table 7. Comparison of the recent results of Beck and Krey (Be82) based on contemporary measurements of ^{137}Cs with those of the TMCEFD.

Utah location	Estimated exposure, R		Ratio
	Be82[a]	TMCEFD	
Beaver	$\leq$ 0.42	0.25	$\leq$ 1.7
Cedar City	0.42	0.64	0.65
Enterprise	1.2	0.79	1.5
Hatch	$\leq$ 0.42	0.54	$\leq$ 0.78
Hurricane	2.9	3.5	0.84
Kanab	0.49	1.6	0.31
Kanarraville	0.49	1.9	0.26
La Verkin	2.9	3.7	0.79
Milford	$\leq$ 0.42	0.10	$\leq$ 4.2
Minersville	0.69	0.20	3.5
Modena	$\leq$ 0.42	0.54	$\leq$ 0.78
Mt. Carmel	$\leq$ 0.42	0.94	$\leq$ 0.43
Panguitch	0.28	0.70	0.40
Paragonah	0.77	0.42	1.8
Parowan	0.77	0.42	1.8
St. George	2.6	3.7	0.70
Santa Clara	1.7	4.3	0.39
Veyo	4.1	2.8	1.5
Washington	1.7	3.3	0.52
Average, geometric			$0.88 \times 2.2^{\pm 1}$

[a]The original numbers resulted from an integration of Hicks' (Hi82) calculations for exposure rate. We converted to a number as comparable as possible to those of the TMCEFD by multiplying by the shielding and time correction factors from Table 1.

LOCATIONS OF SOIL SAMPLES SELECTED FOR FURTHER ANALYSIS

Presented to

THE DOSE ASSESSMENT ADVISORY GROUP

LAS VEGAS, NV; JANUARY 7, 1983

ARIZONA

BE 09	Bullhead City	A	
FM 39	Chinle	B	Tree cover
FM 45	Flagstaff	A	
FM 46	Flagstaff	B	Gravel and rock at bottom
FM 50	Flagstaff	B	Tree cover
FM 54	Ft. Defiance	A	
KS 01	Fredonia	B	Possible area of ranoff
FM 29	Ganado	A	
KS 05	Grand Canyon, North	A	
KS 10	Grand Canyon, North	B	Native area
FM 08	Grand Canyon, South	B	Native area
FM 10	Grand Canyon, South	B	Native area
FM 17	Holbrook	A	
FM 01	Kingman	A	
KS 21	Littlefield	B	Silt present
KS 07	Moccasin	A	
FM 14	Tuba City	A	
FM 43	Williams	A	

CALIFORNIA

BE 22	Bishop	A	
GC 29	Bridgeport	A	
BE 29	China Lake	B	Tree cover
BE 01	Furnace Creek	A	
BE 25	Independence	A	
BE 06	Shoshone	B	Native area

COLORADO

AS 06	Cortez	B	Some disturbance
AS 27	Craig	A	
AS 28	Craig	A	
AS 10	Durango	A	
AS 21	Fruita	A	
AS 08	Mancos	A	
AS 26	Meeker	A	
AS 20	Montrose	A?	Need verification of age
AS 13	Silverton	B	Rock ledge at 11"

IDAHO

MH 22	Boise	A	
MH 19	Boise - Meridian	A	
MH 11	Burley	A	
MH 12A	Burley	B	Native area
AS 43	Idaho Falls	A	
MH 07	Malad City	A	
AS 50	Pocatello	A	
MH 14	Twin Falls	A	
MH 17	Twin Falls - Filer	A	

NEVADA

KS 33	Alamo	A	
GC 20	Austin	B	Small
DZ 01	Baker	A	
RM 06	Battle Mountain	B	Has been flooded
SH 11	Boulder City	A	
KS 25	Bunkerville	A	
KS 26	Bunkerville	A	
RM 21	Caliente	A	
RM 08	Carlin	A	
GC 48	Carson City	A	
SW 06	Duckwater	B	Pasture
RM 10	Elko	A	
DZ 04	Ely	A	
DZ 04A	Ely	B	Oats
DZ 05A	Ely	B	Questioned age
SW 05	Eureka	A	
GC 15	Fallon	A	
GC 19	Gabbs	A	
GC 43	Gardnerville	A	
GC 08	Gerlach	B	Small
GC 33	Hawthorne	A	
SH 10	Henderson	A	
KS 36	Hiko	A	
BE 10	Indian Springs	A	
SH 05	Las Vegas	A	
SH 07	Las Vegas	A	
KS 27	Logandale	A	
GC 10	Lovelock	A	
GC 12	Lovelock	A	

NEVADA (Cont'd)

SW 02	Lund	A	
DZ 09A	McGill	A	
KS 24	Mesquite	A	
GC 50	Moore's Station	B	Pasture
KS 30	Overton	A	
RM 19	Panaca	B	Tree cover
RM 14	Pioche	B	Small
SW 03A	Preston	B	Tree cover
GC 05	Reno	A	
GC 06	Reno	A	
RM 12	Wells	A	
RM 02	Winnemucca	?	Need verification of age
GC 39	Yerington	A	

NEW MEXICO

FM 31	Albuquerque	A	
FM 33	Albuquerque	A	
FM 35	Albuquerque	A	
AS 01	Farmington	A	
FM 16	Gallup	B?	Question of disturbance

OREGON

MH 29	Basque Station	A
MH 28	Hines	A
MH 25	Jordan Valley	A

UTAH

DZ 10	Ibapah	B	Pasture
DZ 21	Iosepa	A	
MH 02	Rosette	B	Meadow
MH 03	Snowville	B	Field (non-lawn) area
DZ 18	Tooele	A	
DZ 16	Wendover	B	Small

WYOMING

AS 41	Afton	A
AS 35	Evanston	A
AS 36	Kemmerer	A
AS 32	Rock Springs	A

SUMMARY

ARIZONA	18
CALIFORNIA	6
COLORADO	9 (1?)
IDAHO	9
NEVADA	42 (2?)
NEW MEXICO	5 (1?)
OREGON	3
UTAH	6
WYOMING	4
	102 (4?)

ADDITIONAL MEASUREMENTS WOULD BE USEFUL

- Deposition of radionuclides in broader geographical area
- Method?
  - Aircraft
  - Field spectrometry
  - Soil sampling

LRA-41

DOSE DETERMINATION

1. Calculate $(^{137}Cs)_N$ at time of arrival
2. Use our standard source-term data to calculate the deposition of other radionuclides
3. Calculate external dose
4. Calculate intake of radionuclides by man, and the internal dose

EML HAS DEVELOPED TWO METHODS OF APPORTIONING ^{137}Cs FROM GLOBAL AND NTS SOURCES

1. Based on current measurements of $(^{137}Cs)_T$ and rainfall records:

$$(^{137}Cs)_G = A + B \cdot \text{Rainfall}$$

$$(^{137}Cs)_N = (^{137}Cs)_T - (^{137}Cs)_G$$

2. Based on current measurements of $(Pu)_T$ $(^{137}Cs)_T$ and the ratio $^{240}Pu / ^{239}Pu$

THE ATOM RATIO OF $^{240}Pu/^{239}Pu$ IS DIFFERENT FOR GLOBAL AND NTS FALLOUT

^{239}Pu is made in reactors:

$$^{238}U + n \rightarrow {}^{239}U \rightarrow {}^{239}Np \rightarrow {}^{239}Pu$$

^{240}Pu is a contaminant:

$$^{239}Pu + n \rightarrow {}^{240}Pu$$

$$^{238}U + 2n \rightarrow {}^{240}U \rightarrow {}^{240m}Np \rightarrow {}^{240}Pu$$

Thermonuclear explosions produce a high neutron flux and also make ^{240}Pu from ^{239}Pu and ^{238}U, and thereby alter the ratio of ^{240}Pu to ^{239}Pu.

(Pu) FROM A MIXTURE OF TWO SOURCES CAN BE RESOLVED BY SAMPLE ANALYSIS

$$\frac{(Pu)_N}{(Pu)_G} = Y = \frac{(R_G - R_S)(1 + 3.73 R_N)}{(R_S - R_N)(1 + 3.73 R_G)}$$

(Pu) = Pu activity per unit area

R = $^{240}Pu / ^{239}Pu$ atom ratio

$R_N = 0.0321 \pm 0.003$

$R_G = 0.180 \pm 0.006$

From EML-400

THIS ALLOWS THE CALCULATION OF $(^{137}Cs)_N$

$$(Pu)_Q + (Pu)_N = (Pu)_S$$

$$(Pu)_Q = \frac{1}{1+Y}\,(Pu)_S$$

$$(^{137}Cs)_N = (^{137}Cs)_S - (^{137}Cs/Pu)_Q\,(Pu)_Q$$

$$(^{137}Cs/Pu)_Q = 53 \pm 1\%$$

From EML-400

MEASUREMENT STRATEGY

1. Select desired communities.
2. Select candidate sites.
3. Measure ^{137}Cs by field spectrometry.
4. Select sites for soil collection.
5. Collect soil samples.
6. Select sites for laboratory analysis.
7. Measure $(^{137}Cs)_T$ and distribution with depth.
8. Select sites for further laboratory analysis.
9. Measure $(^{239+240}Pu)_T$.
10. Measure $^{240}Pu / ^{239}Pu$.
11. Calculate $(^{137}Cs)_N$

THE SITE SELECTION COMMITTEE MET ON JANUARY 5, 1983, TO SELECT SITES FOR LABORATORY ANALYSIS OF ^{137}Cs

EML: H. Beck
P. Krey

DRI: F. Miller

LLNL: L. Anspaugh
J. Koranda

NVO: B. Church
M. Page
D. Wheeler

REECo: H. Hawthorne

LRA-48

SITE SELECTION CRITERIA

1. Prefer large (>40 ft dia.) open, flat areas of grass away from obstructions
2. Must be undisturbed since 1950
3. Not subject to erosion
4. Not subject to accumulation of sediments
5. Field measurement confirms that a reasonable level of ^{137}Cs is present
6. Soil sample is collected successfully

LRA-49

CURRENT RESULTS OF THE SELECTION PROCESS

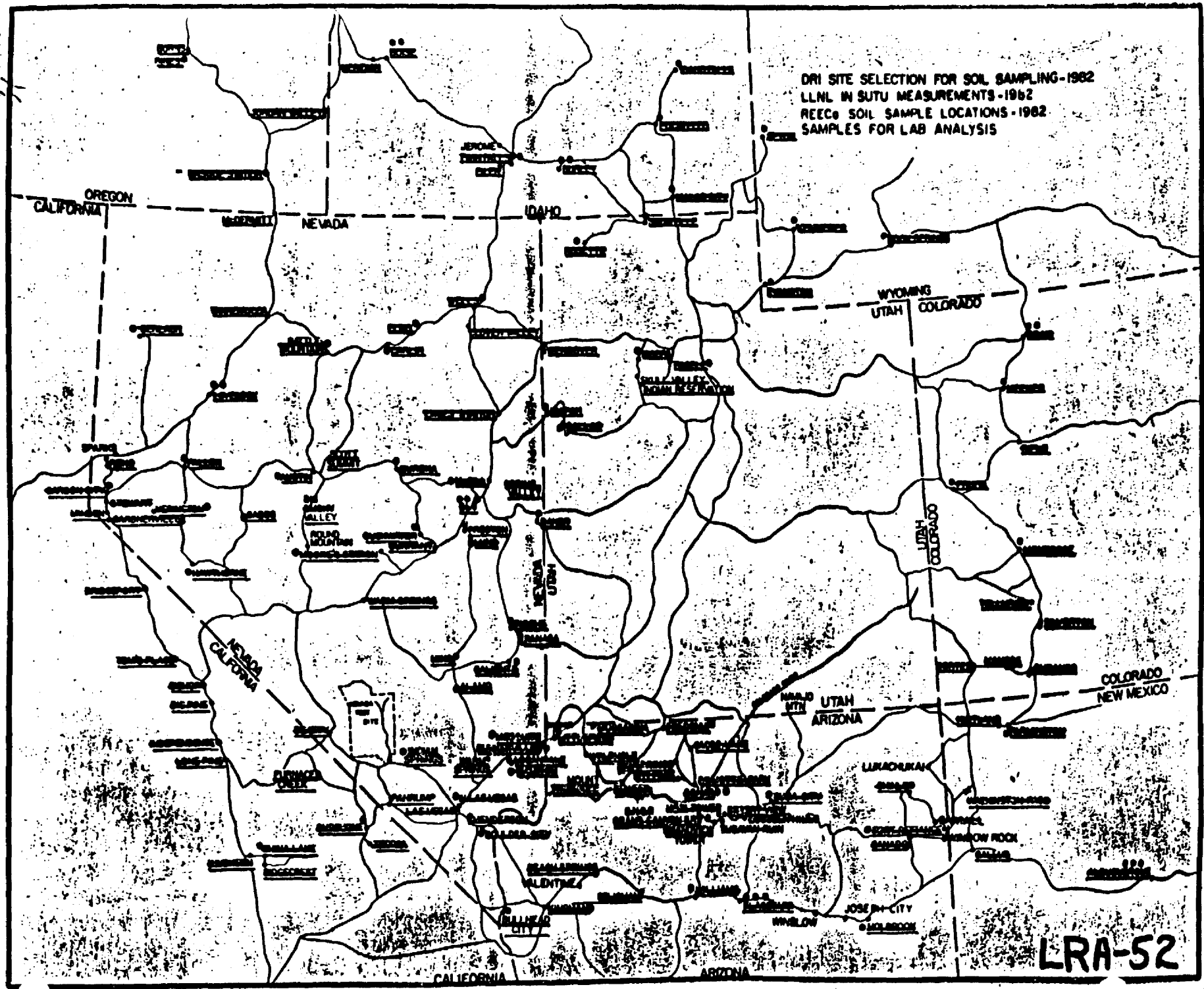
Desired communities	105
Candidate sites	316
Sites measured by field spectrometry	276
Sites sampled for soil	190
Sites selected for lab ^{137}Cs analysis	102

LRA-50

SUMMARY OF SELECTED SOIL SAMPLE SITES BY STATE AND TYPE

State	A	B	?	Sum
Arizona	10	8		18
California	4	2		6
Colorado	6	2	1	9
Idaho	8	1		9
Nevada	31	9	2	42
New Mexico	4		1	5
Oregon	3			3
Utah	2	4		6
Wyoming	4			4
Sums	72	26	4	102

LRA-51


DRI SITE SELECTION FOR SOIL SAMPLING-1982
LLNL IN SUTU MEASUREMENTS-1982
REECo SOIL SAMPLE LOCATIONS-1982
SAMPLES FOR LAB ANALYSIS
OREGON
CALIFORNIA
NEVADA
IDAHO
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
LRA-52

COMMUNITIES SELECTED FOR CORRELATION WITH ESTIMATES OF DOSE FROM OTHER MEANS

Alamo
Bunkerville
Caliente
Duckwater
Hiko
Indian Springs
Logandale
Mesquite
Overton
Ploche

LRA-53

COMMUNITIES WITH MULTIPLE SITES

Flagstaff, AZ	3	Bunkerville, NV	2
Grand Canyon, N., AZ	2	Ely, NV	3
Grand Canyon, S., AZ	2	Las Vegas, NV	2
Craig, CO	2	Lovelock, NV	2
		Reno, NV	2
Boise, ID	2	Albuquerque, NM	3
Burley, ID	2		
Twin Falls, ID	2		

LRA-54

CHAIRMAN MOSELEY: And now the discussion of future activities and time scales. Bruce Church.

MR. CHURCH: This first viewgraph (BC-4) is one you have seen, and I only want to put it up to show that we're now operating out on this end of our time scale. These are some of the things I will be talking about in the next few minutes. We will be endeavoring to make a more detailed time-frame map. We have not accomplished that yet, and it will tend to spread out that region, and we will probably have that ready for presentation at our next meeting.

If I could have that next one. (BC-5). These are basically the major tasks that we've got to accomplish. We've made, I believe, great progress in many of them. I'm going to address each one of these now in some detail.

With respect to the population dose assessment, we have completed the external exposure rate data base. We have yet to complete the distribution data, and you have received some progress report on that. We are discussing and entertaining some considerations with respect to perhaps truck farms and the distribution of vegetables, concerning ourselves with the GI tract dose. We don't know yet what will become of that, but we think that we've got to be a little bit concerned about leafy vegetables and perhaps any other truck gardening that went on within at least the near regions, and what the distribution of that might give rise to in terms of population dose. We need to finish the Pathway Model yet. You are being kept abreast of the progress there. We need to finish the Internal Dose Assessment Model and the External Dose Assessment Model.

With respect to Item 2, we need to complete the External Exposure Rate Data Base, the Individual Dose Assessment Model, and the Pathway Model. With respect to the fallout patterns, we think we have made good progress

in this area. We pretty much believe it is on track. With respect to extending beyond the current fallout patterns, we are pretty well up to speed on our intentions there with respect to the soil sampling, and meteorological modeling. We certainly believe that we will be dealing with some dose assessment because of litigation on an ad hoc basis. The extent of that, I think, we've yet to find out what that will be.

In terms of Phase III, I hope you've gotten a pretty good feel this afternoon, or today, on where we stand in that area. We've got to complete the measurement of cesium. We're in the process of starting the pipeline into the laboratory. The critical thing that remains to be done is to complete the laboratory analysis for both the cesium, then the plutonium isotope, chemistry, and mass spectroscopy. After that we need to go through the arithmetic of apportioning the Cesium-137 from global and NTS, and then using that apportionment to calculate through the mathematics that Dr. Anspaugh just illustrated for you. Beyond that we have to complete our reporting, and I think we're somewhat on track in our planning there. As you are well aware, our intent is to encourage the investigators to publish in peer reviewed journals as much as is feasibly possible. We are entertaining some ideas with respect to wrapping up the project perhaps with a symposium-type of presentation with the conclusion of the tenure of the DAAG. If we are able to develop concrete ideas in that, as soon as something firms up we will be talking to you. Some of the timing has been difficult because of the schedule of the DAAG in its lifetime, and when we might get everything completed.

Of course, the last item is to become operational in a routine manner with the models resident at a single location so we can basically be of service to people who request information concerning their dose. We do have requests from single individuals concerning their exposure and the

result of dose as they resided in the NTS region, and that's totally outside of litigation, but people who are concerned. That's one of the things that this project was to satisfy, is a data base and a mechanism whereby people, when inquiring of their test exposure, could be given a good sound technical answer.

To be specific for the next five or six months, you heard the Weather Service mention that they will be finished with BOLTZMANN in the time frame that was mentioned; you also heard them say that they need some directions on which fallout pattern to do after that. We will be directing them to work on the SMALL BOY pattern probably ahead of NANCY.

If we could have the NURE viewgraph for a moment. (BC-6). The Bendix Corporation has been funded at a level whereby we expect to see ten to fifteen quadrangles in this general area completed this year.

As Dr. Beck mentioned the other day, the area contained within that green has basically been done, or, it is in the process of being done. We have discussed several times today the fact our plans include going back into Utah and resampling what appears on this map (BC-7) as six locations that were sampled by EML with earlier activity, and that ties into about 20 sites that Phil Krey mentioned a few moments ago. In addition to that we plan to sample these other locations indicated by the black dots -- and if you can drop that a little bit so I can see. These are proposed locations at the moment to help us define a little better from a resolution standpoint what the deposition might have been in the region indicated.

As I mentioned earlier, an important element in Phase II is the laboratory pipeline. You've seen the progress and status of that discussed today. REECo is basically set to launch that. They have some additional qualifying to do in the plutonium area. I think they feel our pressure in terms of getting on with that work. We see these things being well

underway in the next six months. Most of these locations that we've indicated in terms of additional sampling, won't take place until the spring thaw, and so the teams won't be in the field probably until the time frame we meet again.

I've got one more viewgraph in terms of soil sampling.

This (BC-8) is the recommendation you made concerning Phase III. These are proposed sites coincidental with the sticky film paper. We propose to look at sites probably west of the Mississippi, probably around a dozen. These do include some sites on the west coast. We intend also to look at the sampling data that EML has previously done in the eastern part of the United States. Perhaps it will be worthy of reviewing the data that they've already collected as we start seeing some of these results to help get a total perspective of what we've commonly referred to as the Phase III area.

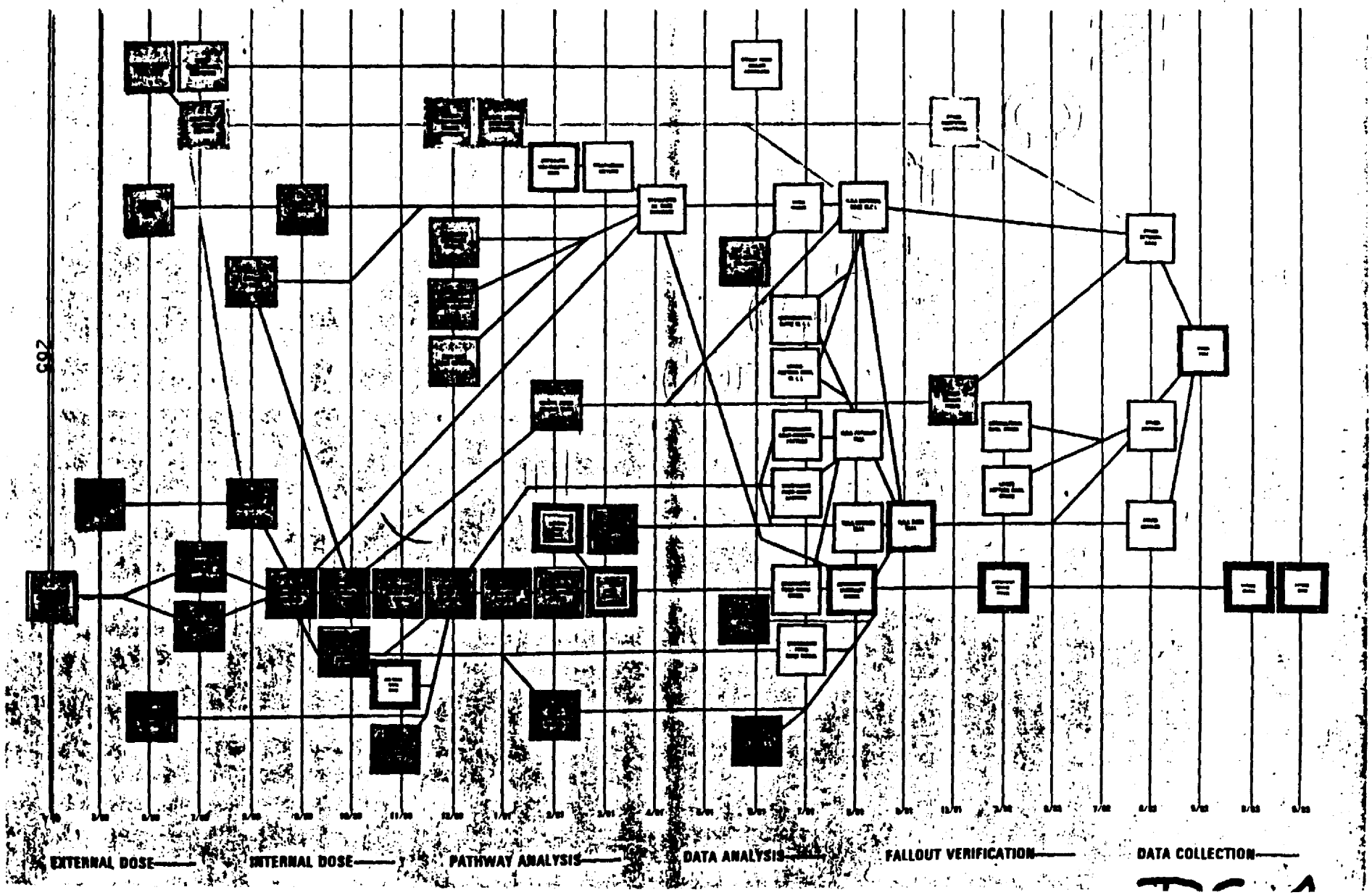
I have, to wrap up my remarks, a request of the DAAG. We have handed to you four draft reports, yesterday and today, reports by Messrs. Burson, Steadman, Rohrer, and Anspaugh, and we would certainly solicit and request your comments and critique on those reports very soon, so that we might move towards publication.

I'd be happy to entertain any questions.

CHAIRMAN MOSELEY: Questions?

Thank you, Bruce.

O.R.E.R.P. FLOW CHART



ORERP MAJOR TASKS TO BE FINISHED

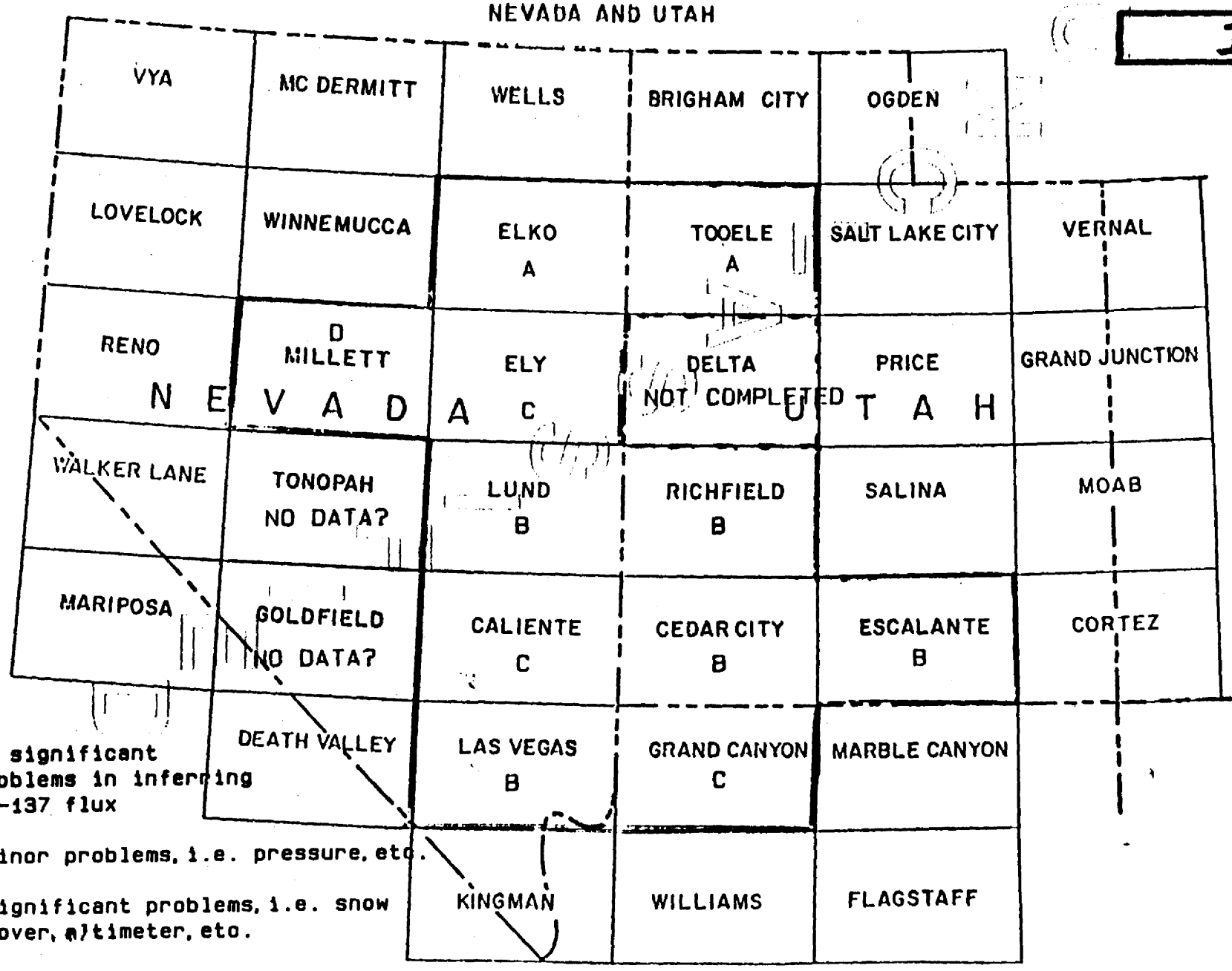
1. Population Dose Assessment
2. Individual Dose Assessment
   a. Inside Fallout Patterns
   b. Beyond Fallout Patterns
3. Phase II
4. Final Reports and Publications
5. Operational Mode

BC-5

STATUS OF NURE DATA ANALYSIS
QUADRANGLE NAMES
OF POTENTIAL INTEREST IN 137 Cs MAPPING
NEVADA AND UTAH

EML (BECK) #

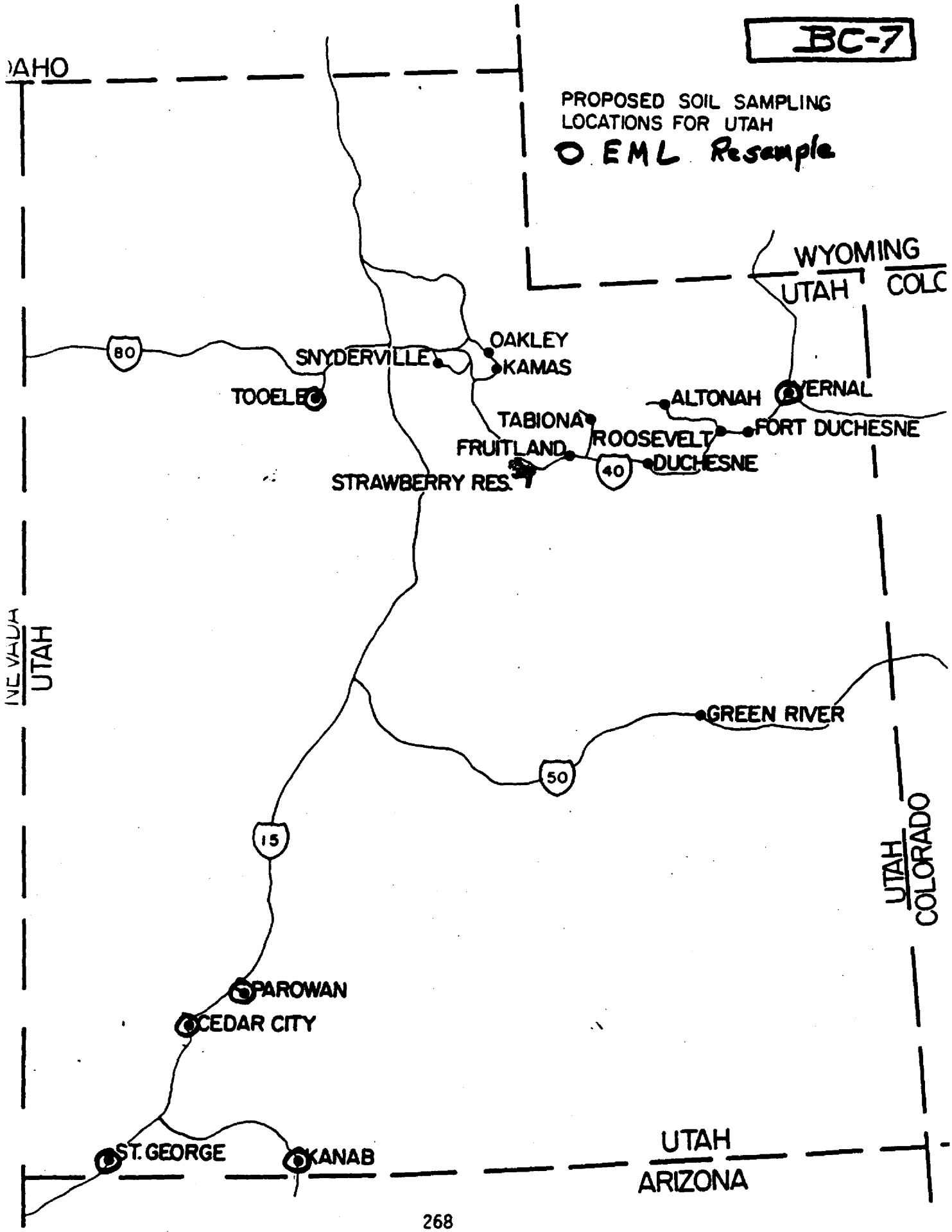
BC-6

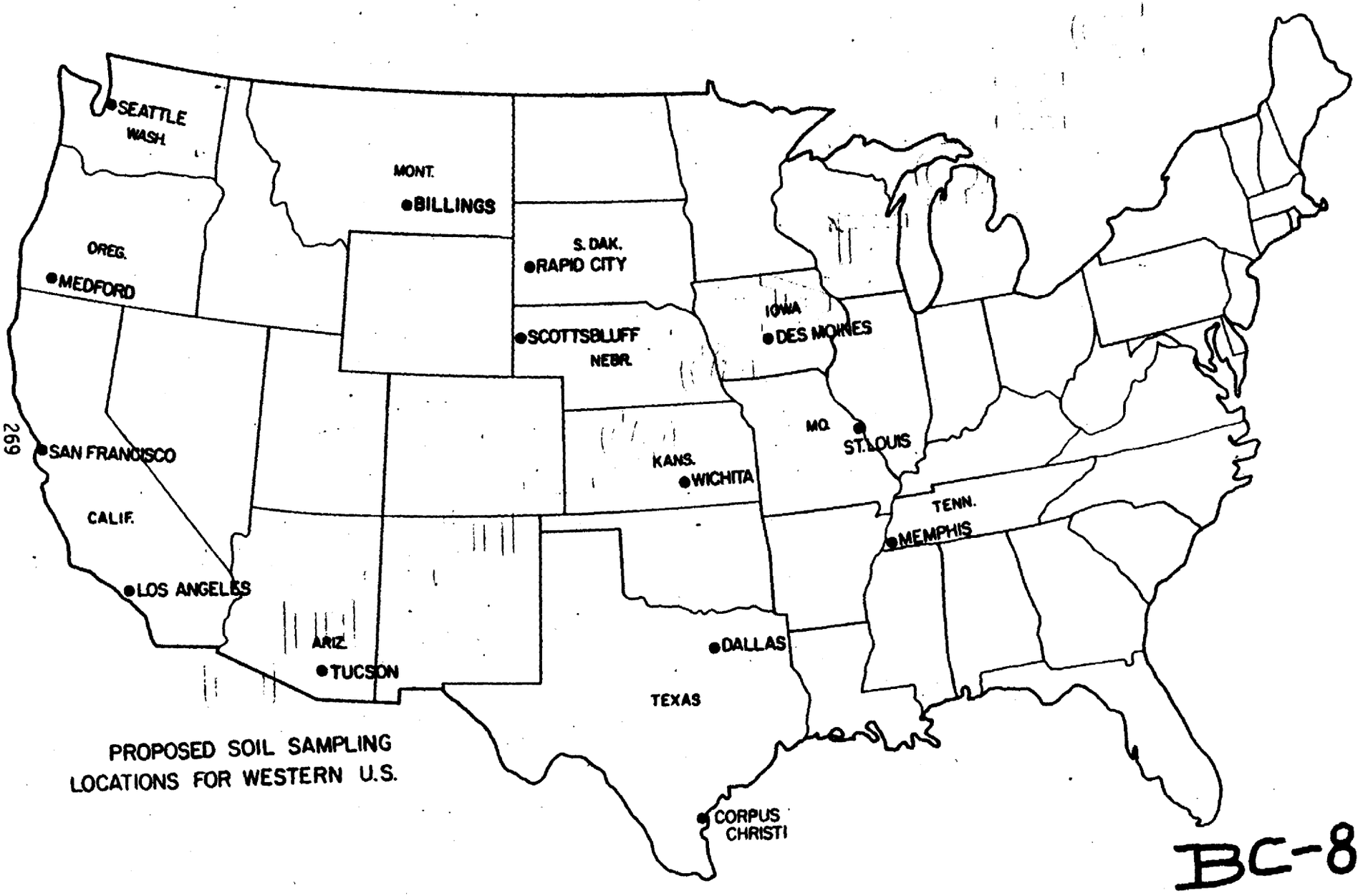


A-No significant problems in inferring Cs-137 flux

B-Minor problems, i.e. pressure, etc.

C-significant problems, i.e. snow cover, altimeter, etc.


BC-7
PROPOSED SOIL SAMPLING LOCATIONS FOR UTAH
EML Resample
IDAHO
WYOMING
UTAH
COLO
80
SNYDERVILLE
OAKLEY
KAMAS
TOOELE
ALTONAH
VERNAL
TABIONA
ROOSEVELT
FORT DUCHESNE
FRUITLAND
DUCHESNE
40
STRAWBERRY RES.
NEVADA
UTAH
GREEN RIVER
50
15
UTAH
COLORADO
PAROWAN
CEDAR CITY
ST. GEORGE
KANAB
UTAH
ARIZONA



PROPOSED SOIL SAMPLING
LOCATIONS FOR WESTERN U.S.

BC-8

CHAIRMAN MOSELEY: As you all know from your reappointment letters, the Secretary of Energy has reappointed the Dose Assessment Advisory Group for another two year period ending in 1984 based on Bruce's Flow Chart, and, I guess, our own projections of things. We believe the task of ORERP groups and of DAAG will be completed by that time.

I felt jealous of all of the Task Groups having viewgraphs, so I thought the Chairman of the Committee ought to have a viewgraph, too. (RDM-1). This is for a dual purpose, to remind you of the Charter of our group, which we discussed in substantial extent at our first meeting in December a couple of years ago. The Charter is unchanged except in one facet. The initial Charter called for us to meet quarterly; and as our task progressed, it seemed reasonable to allow longer periods of time between the meetings to allow the Task Groups to accomplish more of the scientific effort without being interferred with by having to prepare for another Dose Assessment Advisory Group meeting. This Charter differs from the first one in that it removes the requirement, which we had to petition to have removed initially, that we meet quarterly, and now it says that we meet at least semiannually. We can meet more frequently than that, but we need to meet semiannually, which is probably an adequate schedule for us.

Maybe I'm a little more exorcised about this than I should be. The Media in Las Vegas last night, or this morning, characterized me as a DOE official. I'm neither an official of the Department of Energy, nor an employee of the Department of Energy, nor have I ever been in my entire career in either of those capacities. I've served on two committees of the Department of Energy and its predecessor agency, the Atomic Energy Commission, this one, the Dose Assessment Advisory Group, and the Advisory Committee on Biology and Medicine of the Atomic Energy Commission in the mid-sixties to the early 1970s. I, and all of the other members of this

Committee, serve without stipend, honorarium, or even complete reimbursement of their expenses, in attending these sessions. I think that it is a little calumny to imply that the public spirited members of this Committee, who give from their own time and their own direct professional interests to serve their country in this capacity, would be considered to have anything except the motivation for seeing that the United States and that the people of the United States be properly served by their advisory efforts.

You can see that our Charter requires that we have three real functions about the middle of the Committee's objectives, scope, activities, and duties. As a multi-disciplinary group of experts, this group provides effective and objective working level advice and recommendations to the Manager of the Nevada Operations Office in the planning, organization, and technical direction of the Dose Assessment Project. And, secondly, what we have been doing at this meeting and at previous meetings, we review the activities of the project and ask occasionally a name but not infrequently searching questions about the direction that the project is going. In reviewing the impact that the Dose Assessment Advisory Group has had on the Task Groups, I think it has been both a definite one, hopefully, and, I really believe, a useful one, as we have commented on the directions that the research effort should take in order to establish the credibility of this effort. And, thirdly, we report on the progress of this project after each of these meetings with a full transcript of our activities in addition to a summary with identification of problems and recommendations that we have both to the Secretary of the Department of Energy and to the manager of this office as well as individuals involved in the supervision of the project.

I don't know how one establishes credibility in this regard. The

Federal Advisory Committee Act attempts to assure that Federal Advisory Committees are established in a way that should insure their credibility with the public in that it requires that the Committee have representatives from the public sector, as this Committee does, with one representative from California, representing both the governor and the people of California, and two representatives from Utah, representing the people and the government of Utah individually. The two from Arizona and the two from Nevada having exactly those same relationships. In addition, while there are three or four members of the Committee whose present occupations, or past occupations, have to do with operations of national laboratories or contractors of national laboratories, many of the members, I guess the majority of the members, including those who represent the public, are individuals who are not "government scientists" at all but who come from various universities and other research groups around the country. The individuals on the Committee, who have some direct relationship with the Department of Energy operations, in my opinion, are obligatory to the proper functioning of the Advisory Group, because we need their expert knowledge in some areas in which we deliberate.

In essense, I believe that our Charter is a reasonable one. I believe that we decided it was a reasonable one two or three years ago when we started working on this; and it is my opinion that the Advisory Group is discharging their efforts in relation to this Charter in an appropriate, if not exemplary, fashion.

I thank you all for being willing to serve on the Advisory Group given the financial and other restraints that I mentioned earlier.

Department of Energy
Charter
Dose Assessment Advisory Group

1. Committee's Official Designation:

Dose Assessment Advisory Group (DAAG).

2. Committee's Objectives and Scope of Activities and Duties:

The DAAG provides the Secretary of Energy and the Manager, Nevada Operations Office (NV), with advice and recommendations pertaining to the Offsite Radiation Exposure Review Project. This project concerns the evaluation and assessment of the potential amount of radiation received by members of the offsite population surrounding the Nevada Test Site (NTS) as a result of atmospheric nuclear test operations conducted at the NTS. The function and role of this advisory group are threefold. First, as a multidisciplinary group of experts, the group provides effective and objective working-level advice and recommendations to the Manager, NV, in the planning, organization, and technical direction of the project. Second, the group reviews the activities of the project. Third, the group forwards copies of all reports on the progress of the project including the identification of problem areas, if any, to both the Secretary of Energy and to the Manager, NV. The Manager, NV, will maintain management and administrative supervision of the project. The group will act in an advisory and review capacity to the project. The Secretary will receive and review reports of the group and, where appropriate, resolve problems which might arise.

3. Time Period Necessary for the Committee to Carry Out Its Purpose:

The advisory group is expected to complete its purpose in another two years (July 1984) at current funding levels. Appropriate actions will be taken to obtain an extension at the required two-year interval, if found necessary.

4. Official to Whom This Committee Reports:

The advisory group will report to the Secretary of Energy and to the Manager, NV.

5. Agency Responsible for Providing Necessary Support for this Committee:

The Department of Energy (DOE). Within DOE, primary support shall be provided by NV.

6. A Description of Duties for Which the Committee is Responsible:

The duties of the advisory group are solely advisory and are stated in paragraph 2 above.

7. Estimated Annual Operating Costs in Dollars and Man-Years:

The estimated annual operating cost of the DAAG is $130,200 including two man-years of part-time staff support.

RDM-

8. Estimated Number and Frequency of Committee Meetings:

The advisory group is expected to meet approximately three times a year, but at least semiannually, and may meet more often if necessary.

9. Committee's Termination Date (if less than two years from the date of establishment or renewal:

Not applicable.

10. Subcommittees:

To facilitate functioning of the advisory group, subcommittees may be formed. The objectives of the subcommittees are to make recommendations to the parent committee with respect to matters concerning DOE plans and programs which are related to the responsibilities of the parent committee.

11. Members:

a. Advisory group members shall be appointed by the Secretary of Energy. Membership terms shall be subject to review every two years, unless terminated earlier. Members, whose initial terms have expired, may be reappointed to additional terms following review.

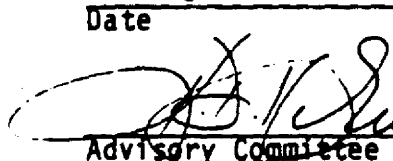
b. Approximate number of members: 20.

12. Chairperson:

The Chairperson shall be appointed by the Secretary of Energy.

This charter for the advisory group named above is hereby approved on:

July 15, 1982
Date



Advisory Committee Management Officer

July 15, 1982
Date filed

DR. MOSELEY: I'd like to bring up another temporal factor for us. We've got to decide when we are going to meet again. I have two suggested dates. If you will look at your calendars, the first dates are May 12 and 13th. Anybody have impossible conflicts for that period that they know about at this time? May 12th and 13th. That's a Thursday and Friday.

DR. SARN: I have a Cabinet meeting.

CHAIRMAN MOSELEY: A Cabinet meeting. That probably takes precedence. Dr. Miercort is unavailable the first week in May. Would the first part of that week be all right with you, Dr. Sarn, or would that be impossible, too?

DR. SARN: I also have trouble with the first week in May.

CHAIRMAN MOSELEY: Why don't you tell me what is available for you in May?

DR. SARN: How about the 19th and 20th, or the 26th and 27th?

CHAIRMAN MOSELEY: What about the 19th and 20th? Everybody say okay? We will shoot for that. There are members who are not here. We will try to correlate the situation so that we can have the maximum attendance at the meeting.

The next one is a little further off, and I would propose October 13th and 14th. That again is a Thursday and Friday.

DR. AUXIER: I have a conflict, Bob.

CHAIRMAN MOSELEY: What dates are available for you in October?

DR. AUXIER: The 20th and the 21st of October.

DR. SARN: Good. Mr. Chairman.

CHAIRMAN MOSELEY: Yes, sir.

DR. SARN: We have thought in the past about having meetings in other places beside Las Vegas. I think that prior to this date we've always felt that just the sheer number of people who had to be in attendance made it

less expensive to have it any place else but here. I am wondering whether, in fact, it might be time to think about having it in another location.

CHAIRMAN MOSELEY: I agree that we even said the Committee wished to do that. It wasn't just that we were going to explore the issue. We run into climate problems for one thing. We had planned to go to Ely, but it coincided with our winter meeting which didn't work out very well. May or October would probably not represent transportation problems here, and I think we ought to ask Marshall to see if we can't arrange such a meeting for either one of those dates at some non-Las Vegas site. St. George or Ely have been the two that have been discussed in the past. I think it probably still does impact financially, as a matter of fact. It will be more expensive to have the meeting somewhere else, but the Committee has asked that we look into that, and I wish we would.

DR. SARN: How far is St. George?

MR. PAGE: 135 miles from here. Ely is 284 from here.

DR. SARN: Can we get an expression of which place we'd like to meet in May, Ely or St. George?

CHAIRMAN MOSELEY: Where would you like to meet in May, gentlemen?

DR. SARN: St. George.

DR. CAROTHERS: Las Vegas.

DR. CALDWELL: Las Vegas.

(Laughter)

DR. SARN: Can we let Marshall look into that?

CHAIRMAN MOSELEY: We will let Marshall look into that. I'm getting a diversity of opinion on the Committee now, Dr. Sarn. It doesn't make any difference to you?

DR. SARN: I don't care which place.

CHARIMAN MOSELEY: And Roger, you said Las Vegas, or were you just

mumbling?

DR. CALDWELL: I mumbled. I can float either way.

CHAIRMAN MOSELEY: We have one positive vote on the Committee for Las Vegas, and -- three votes for Las Vegas.

MR. ZIMMERMAN: I vote for one of the two spots, St. George or Ely.

DR. AUXIER: Which one of them has the best airport?

CHAIRMAN MOSELEY: Well, neither are prepared for 747s.

MR. ZIMMERMANN: Actually, as I recall, St. George used to have some short jets that went in there.

CHAIRMAN MOSELEY: St. George has commercial service from Las Vegas as well as from locations in Arizona.

MR. PAGE: So does Ely.

DR. AUXIER: Okay, no problem.

MR. ZIMMERMAN: I would say at some point it would seem to me that St. George would be an appropriate place at some juncture simply because there seems to be at least a significant amount of interest in that area apparently.

DR. CASARETT: What do you have to do to get in and out? Do you have to go to them from Las Vegas and then come back to Las Vegas to get out?

MR. ZIMMERMAN: No. You can go to Salt Lake and go to St. George. I know you can do that.

CHAIRMAN MOSELEY: Or you can come to Las Vegas and go to St. George.

DR. CALDWELL: Would it be better to come here and then get ground transportation from here?

CHAIRMAN MOSELEY: I think that we can't solve that issue. We will let Marshall work out the logistics of what we are going to do.

Any other discussion about the meeting dates? Or place?

I need to have our normal recital then. I guess I will start with

Dr. Malik who is closest to me here.

DR. MALIK: Three areas. One on hotspots. The work reported on at this meeting by EG&G for the Surface Nuclear Report Office and REECo has done much to clarify the so-called hotspot designation in the observed fallout patterns. In particular, the famous BOLTZMANN hotspot, which had no plausible explanation, now appears to be nonexistent. Many others in the environs of the NTS have also little credibility. If a quantitative definition could be established, more might disappear from the patterns. Such might be established in consideration of the variability of exposures established along the hotline. The variables might include terrain effects, variability of the particle size distribution, wind shears, and so forth. A limited effort on this description might be useful. One should note the hotspots are, indeed, real. Examples are: TRINITY, HOROSHIMA, SIMON and SMALL BOY. The NURE data seemed to say that the historical fallout patterns are probably complete with high level hotspots unlikely. Analysis, however, was not completed. On pathways, the work to date seems to agree with the limited data base but with large error voids. They have a long way to go. On soil sampling, this is a very essential study area in the effort. Work seems to be proceeding well but is only started. My concern about mechanical concentration of fallout does not seem to be warranted. This from a comparison of the recent versus the Larson samples. These data will be of great interest. We have seen some impressive progress.

CHAIRMAN MOSELEY: Dr. Caldwell.

DR. CALDWELL: He has already hit one of mine. One of the things that I'd thought about when we were looking at some of the reports and at the same time talking about the CIC was I think that DAAG needs to consider whether or not the funds shortfall for the CIC, particularly for keyword

insertion and some of those things, whether we ought not to urge that they replace some of that shortfall and maybe try to get the Adjustments Department, who chewed up a fair amount of those funds, to provide some to us.

(Laughter)

The other thing was one that had occurred to me before I got out here. We had scheduled Harold Knapp to talk to us once before. I wondered more whether or not that was still appropriate and whether it would be useful. I don't know, and I think that needs to be decided by Lynn and Bruce Church as to whether or not that would be useful. It was something we did not do and had planned to do.

My last comment is related to the facts and assumptions. We have complained about that in the past. I think there was a great effort made to provide those things to us this trip, and I think we ought to compliment the Task Groups. There were a couple of places where I wasn't sure which was fact and which was assumption, but I think that will work out as time goes on. I think they have made considerable effort to do that; so they should be complimented.

I think those were the only things I had written down.

CHAIRMAN MOSELEY: Roger.

DR. MC CLELLAN: I only had a couple of items. One related to the CIC. I think there's a need for them to really critically examine, this is something that could be done very easily, the litigation process to determine if it is likely to provide opportunities in terms of documentation, development of documentation that should be included in the Center, and if those opportunities are identified then to establish the vehicle by which those appropriate documents can be entered into the collection.

The second item is really one of -- I guess I'd have to say, I cannot really support Glyn's recommendation with regard to the funding shortfall

for the CIC, because I continue to be perplexed as to the level of productivity relative to the level of funding and really what I view as relatively meager information that has been provided to us with regard to the time lines and the establishments of the priorities for work within that Center. That leads really to my second recommendation which is for a critical examination of the material that is now on hand for entry, or likely to be provided for entry, and to the establishment of priorities to enter that material into the collection and continuation of the work in terms of key words.

I guess I can best sum it up by saying, I suspect that there are documents that await handling by the Center that would be categorized in the ten cent range; there are probably some that are worth a dollar; there are some of the $10 variety; there are probably some that are of the $100 variety; there may even be some, oh, $10,000 pieces of information there. When the information has been presented to us here, I sometimes have the impression that the ten cent items are handled with about the same priority as the $10,000 or vice versa.

The other item is one, and I may have frought my attention or recalling in thumbing through the article here by Anspaugh and Church, and this goes to the question of the extent to which there is in one place information in terms of natural background exposure levels across the region of interest, and I think that just as a general matter of practice it would be useful to take the opportunity to call those background exposure levels to the attention of the interested individual anytime the exposure and dose information is provided from the program here. I'm struck by the extent to which in many cases the levels of exposure attributable to the fallout are disappearing into the background that is naturally there.

And the other area is one which I do not know that anything realistically can be done as a part of this, but it seems to me that it is appropriate to keep in mind, although admittedly provided for a specific purpose, i.e., the use of medical diagnostic radiation exposure. It seems to me that somehow that has to -- we have to keep in mind that as a factor here. My overall concern is one that -- As I look at many of these numbers, I am concerned that we tend to become, well, mesmerized, or give them undue weight, and we do that in terms of reporting of the values to two, occasionally to three significant figures when perhaps an order of magnitude would be more appropriate, or even more appropriate in other cases as the recording has de minimis values.

CHAIRMAN MOSELEY: May I say that the Chair was planning to comment that this was the first time he had heard from you the admonition to expand the activities of the CIC, and I'm delighted that in your second recommendation you quickly kept me from being disillusioned with your watchdog-type activities in this regard.

DR. MC CLELLAN: I appreciate the commendation from my colleague from New Mexico.

(Laughter)

DR. WARD: Mr. Chairman, I think there are two issues that might be of priority to those of us who seem to be outside of the blackest of the cloud that has been predicted here. That would be to have Dr. Whicker do a little bit more work on the consequences, if any, to those of us who may be recipients of food and fodder grown here, sort of secondary inheritors, if you will, of the problem that may be local. And the other thing, of course, is the correlation between the soil sampling that's being done now and the extended modeling of the fallout to make sure that we are not too comfortable by seeming to be outside the centerline of most of the things

that have happened here over the years. That would be my two priorities.

CHAIRMAN MOSELEY: Thank you. Mr. Zimmerman.

MR. ZIMMERMAN: The hotspot issue, I was impressed with the resolution of the BOLTZMANN hotspot. I wondered about whether any attempt is being done to do any soil sampling in the same area to get any further verification of its nonexistence. At least it's always seemed to me that the possibility of hotspots which at least heretofore has always been accepted was always a question mark in any analysis, no matter how exact it appeared to be. I would just suggest that maybe some more could be done to nail down some of the other hotspots, whether it be by the sort of thing Dr. Malik suggested, topographical justifications for them; whether they're really cool contours in a continuous hot contour, something like that.

The REECo CIC work, my first impression was at the rate they're going it's going to take them about 15 more years to do what they are supposed to do. That either calls for more money, or it calls for what Roger is suggesting, a little more selectivity. Maybe it calls for both. But it did strike me that the selectivity might be more useful in terms of getting the most out of the money at the present time, because there does not seem to be any attempt to sort out the important from the unimportant.

Also, with respect to the litigation data, it seems to me that it is quite possible that information is very pertinent to the ORERP effort that will be turned up during the course of the litigation either by way of deposition or possibly even conceivably by studies paid for and done by plaintiffs, and that at present there does not seem to be a mechanism for bringing that into CIC. That might be some at least $10 or $100 information, and a mechansim ought to be set up to do that one way or another, and I would not suggest that the government attornies pick and choose among things. Perhaps they ought to just send all the depositions down, or some-

thing like that. I don't know how you are going to do the screening. Being an attorney, I frankly don't always trust the attornies to do the picking and choosing about what gets into the library, but some mechanism needs to be established.

I thought, a comment I made before, that it's important that the Utah milk studies, whatever they are going to be, be very closely coordinated with the CSU work, so that it is very congruent. I noticed when we heard about REECo's cesium work and plutonium work, and then EML's which have been going supposedly hand-in-hand, they are using different chemistries. One had already developed a chemistry, and the other, at least it appeared to me as a layman, to have reinvented the wheel. I would hope that we could avoid that kind of problem with the milk work.

And the soil sampling, it may be because I missed a meaning, but I'm somewhat concerned about what appears to me to be an absence of sampling in the Utah County, Heber City areas, which are the milk sources for Salt Lake and the Wasatch front where the bulk of the Utah population is. It may be that that was done in the first EML survey that we saw about a year and-a-half ago; but I don't particularly recall it as being related to the milk producing areas.

That's all I have.

CHAIRMAN MOSELEY: Can we clarify that issue right now without carrying it to our summary? It's my recollection that there was a fairly extensive EML sampling in Utah, and that this committee's recommendation was that some of those be resurveyed in this process in order to cross-validate the two efforts and be certain that the methodology gave similar results; but that not all of those areas be resampled again. That does not speak to the question about the specific areas that you talked about, and maybe Bruce or some of the folks from EML can respond to that.

Do you know, Phil, what your Utah --

MR. KREY: I'll be very truthful with you. I don't think I know geographically where the milk area is for Salt Lake City. Is it around Heber City?

MR. ZIMMERMAN: Actually, I think, was it Ward's data that talked about Utah County, Provo, and some of the mountain valleys which would include Heber City. Around Oakley and Kamas there's some grazing. But Utah County, as I recall, he indicated was the primary -- Utah County and Cache Valley were the primary milk producing areas.

MR. BECK: Our measurements, we had extensive measurements in the cities in that region. We did not have any measurements outside the cities. Now Bruce told you he was going to have some additional sampling made in Roosevelt and Duchene County. The purpose of that, I understand, was just to address this question, to fill in those areas. This may be where we want to move those additional sites to satisfy your requirements here, but we had extensive measurements throughout that whole area; but only in the cities --

CHAIRMAN MOSELEY: Based on your methodology, the cities with the established lawns were the best spots from your standpoint; so that a meadow, or a grazing area, might not fit your criteria as an optimum site to sample.

MR. BECK: I think one thing that our data showed was that essentially that entire area was fairly uniform in its NTS cesium deposition, so I felt we had established pretty much what the deposition of NTS cesium was, and that it was fairly uniform over that area. I think that there are going to be enough additional samples taken in this Phase II effort to corroborate that, and if they come up with the same results, I think we can go with that assumption.

CHAIRMAN MOSELEY: Was that clarified to a certain extent?

MR. ZIMMERMAN: Yes.

MR. CHURCH: Mr. Chairman, I think it is probably also appropriate to clarify the chemistry techniques. We either didn't make it clear, or we made it confusing, that the REECo chemistry procedures is an identical procedure to the EML one. If I'm wrong, somebody correct me.

MR. BECK: That's correct.

MR. KREY: No, that's correct.

MR. ZIMMERMAN: That impression I got was that it was something different because you were talking about eliminating the thorium, as I recall.

MR. KREY: They are using the exact procedure. There is a little bit of uncertainty as to why the thorium and the polonium is showing up in the final product. There are some chemical reasons that we can propose that might explain it, but the procedure is identical, and the confusion part is, why did they get that when we don't. But the chemistry is exactly the same, at least as I understand it.

CHAIRMAN MOSELEY: Dr. Sarn.

DR. SARN: I don't think I can resist saying something about the CIC; but I would say with the limited funds of CIC, we'll need to be selective with regard to what kind of information it's going to gather and store, but at the same time it must also be concerned with information which has been shown to have a high public interest in addition to information that is purely technical or scientific in nature. I think that, without being dramatic and being mindful of other momentous events in the history of the world, I think the creation of nuclear weapons and its testing is certainly one of the key historical occurrences in the history of man, and I think people who operate very close to it sometimes fail to realize the

importance of it to the general public. These records, I think, should be viewed as exceedingly useful to not only scientists but to public officials, individual citizens, and their legal representatives. I would suggest that we are on the side of gathering more rather than less information within reasonable limits, and, specifically speaking to the issue of the trial information, that I find that -- or, I believe we will find that to be very useful, and so will people in the future, and it appears to be important enough for CIC purposes.

On the dose reconstruction and soil sampling, I was just very pleased to see the intensity of the work in that area and the output of the staff. Since the very beginning, I think that has been a key issue with representatives from Utah, Arizona, and Nevada, and I believe that the lack of accuracy of the airborne readings just begins to bring that out further, the importance of having this reconstruction especially in areas that did not have ground monitoring during the fallout. I think that the staff should be commended in this area, and that we should continue to emphasize work in this area with both our own interest and resources for these undertakings.

I think of one other issue and that is a final report. I saw Bruce putting up his concern for some of the committees, publications, and presentations, and I think it is appropriate for us at the next meeting as an advisory group to begin to outline what we believe should be our analysis of the effort and begin to assign people on this advisory group with some responsibilities for final publication information, because I think that will roll around very quickly in a year and-a-half. With the kind of intensity of effort that's being shown in all of these areas, it will be just around the corner.

CHAIRMAN MOSELEY: May I make a comment in connection with that last

one. I would remind you of Bruce's request that documents that you have there in the preprint state be reviewed in relation to your areas of expert knowledge and that the authors be communicated with about any comments that you might have about it, so that it gets some additional peer review before it goes for publication.

John. Dr. Auxier.

DR. AUXIER: I have no substantive technical comments or suggestions now. It still appears to me, as we have observed before, that the ORERP has been positively responsive to the DAAG suggestions, and I think the work is progressing in a very professional manner. The things we've heard at this meeting that we've received have helped clarify several long-term problems including that old bug-a-boo of the hotspots; but I would be surprised if when all is said and done if there are not areas found wherein the exposures are somewhat higher than in surrounding areas, than the immediately adjacent areas, and I still have a slight nagging concern concerning soil sampling in areas that are subject to extensive use of sprinkling and soaking. I think it is perhaps just a problem I have in not having looked at it that long in how I would interpret the data. We know in a general sense how nuclides progress through soil, depending on their solubility and other factors, but I worry about this. Like we picture a lawn with sprinklers going. I wouldn't personally know how to handle that right now.

CHAIRMAN MOSELEY: Dr. Carothers.

DR. CAROTHERS: With regard to the items presented on Thursday, I have no recommendations. As an observation, I am pleased to see the analysis being done on the NURE data. This ties in with comments with respect to Friday. I have no recommendations for the items on Friday either; however, as an observation, I believe the Phase II soil sampling program is

providing a very important base line data set, not only for the present, perhaps temporal, purpose of assessment of dose from NTS fallout but for possible future events which might occur. It appears to be being carried out in a careful and excellent fashion. Since I think it is so important, I believe all possible checks should be made to ensure that this data set is as soundly based and documented as is reasonably possible, and any possible ties to the NURE analysis should also be made for much the same reasons as above.

CHAIRMAN MOSELEY: Thank you. George.

DR. CASARETT: In general the ORERP investigators continue to be highly responsive to recommendations and suggestions from DAAG to the extent that is reasonably feasible, and I feel that Bruce Church and Lynn Anspaugh have made it clear to us those suggestions that don't seem reasonable and feasible and those which are. In general, the progress toward achievement of the overall research objectives and completion of specific tasks appears to have been excellent, especially in view of the substantial time and effort that has been devoted recently to provide information in litigation processes.

The ORERP investigators, therefore, should be congratulated on their high levels of competence and conscientiousness in this work.

In view of the progress made toward assessment of the extent or validity of so-called hotspots, it does seem advisable to define this jargon term more formally, if not replace it. Presumably, by implication, there may also be cold spots. Definitions could be made in terms of some minimal factor or factors of difference distinguishing extraordinarily high or low radiation exposure in demarcated subareas relative to the exposure in surrounding larger areas characterized more generally or uniformly by elevated exposure; something of that sort, and whether you call it hot-

spots, or cold spots, or whatever, it doesn't make much difference.

In regard to tables or text dealing with doses in rads, or with dose equivalents in rems, it would be useful to accelerate the implementation of previous suggestions to establish and consistently practice expressions of types of radiation involved, and where involved, quality factors used, or assumed, to know that we're getting penultimate drafts for review by DAAG. Perhaps we should take a hard look at factors of this sort.

I'm simply advising that you not take for granted that everyone who reads these documents, especially with the public attention now being given, is going to understand what you mean without expressing these factors we all take for granted.

The CIC archival effort seems still to be indiscriminately encyclopedic in character and for imminent purposes needs a practical set of guidelines for relative effort in relation to relative importance of various categories of information for early processing.

Those are the only thoughts I have at this time, Mr. Chairman.

CHAIRMAN MOSELEY: Thank you.

I will open the meeting now for public comments and questions.

Hearing none, I will adjourn this meeting of the Dose Assessment Advisory Group.

MR. CHURCH: Mr. Chairman.

CHAIRMAN MOSELEY: Yes, sir.

MR. CHURCH: Could I make a request before you adjourn?

CHAIRMAN MOSELEY: You were almost not in time. (Laughter)

MR. CHURCH: I'm perplexed by the comments with regard to the CIC. There apparently is an area where we have had a hard time striking harmony with respect to level of effort. We have tried to balance, in terms of responding to DAAG recommendations, a level of effort somewhat below what

the initial design of their budget was. It was largely upon DAAG recommendations that their budget was diminished in favor of resources going to other aspects of ORERP activity. Our early intention had not been to do that but to obtain funding perhaps from other sources as we dealt with the technical requirements of the project.

It would help me considerably if we could consummate a firm set of recommendations from the DAAG with respect to what they saw the utility of the CIC to be; what you see an appropriate level of effort to be. It 's clear, I believe, that the current level of effort cannot satisfy the archival activities for potential document sources that are out there, and I think that is now clear to you. In the way of information, there are other types of needs, primarily litigatory, where we are now meeting to perhaps create additional tasks for the CIC to supplement and support litigatory efforts. In fact, week after next I will be attending the Task Group meeting at the Headquarters where we will be looking at that type of thing.

From our perspective, the CIC has provided an immensely important role. I think it has provided also an important role for the public and their attornies. I think -- this is strictly an opinion on my part -- they would have had a difficult time presenting a case without the resources of the CIC for the Allen trial. One of the primary objectives of the CIC was to make government documents available to the public. I think we need to endeavor to complete that. We need, I believe, to hear from the DAAG with respect to what your recommendations are. I feel I am a little bit on a yo-yo. Our time is not long enough to go up and down that loop more than one more time.

CHAIRMAN MOSELELY: I appreciate your problem, and I'm certain that the ambiguity that you are receiving is based on the fact that there really

isn't a consensus among the members of the Dose Assessment Advisory Group, as you can detect from listening to the recommendations made at this meeting. Whether we can provide a precise outline of what we believe the CIC's obligations can do, since we don't seem to have very much agreement about it among ourselves, is not something that is patent to meet at this point, but I will ask the members of the Committee to provide me by mail, in addition to the documents that you will give me now for the preparation of the summary, your individual assessments of the CIC's mission and recommendations for our accomplishing it in the most expeditious and cost effective way.

MR. WHEELER: I think there is a misunderstanding in the report that was given by the CIC on the type of work that still needs to be done. As far as identifying government records that were not available to the public, I think all of those records are currently, the $10,000 records are currently on the system and available. The records still that need to be done are those that are in collections or in archives in other locations which have not been entered into the computer system, which are accessible, which are researchable, which are available other places, are your records of less quality. I think we have done the type of prioritizing of which records get into the system first. Those are the ones we have requested, and I don't understand what the requests are for this prioritizing of records. It seems to me like we've done it. Maybe we haven't communicated.

CHAIRMAN MOSELEY: If your statement is correct, I would interpret many of the members' opinions as, if you've gotten all of the $10,000 records and some of other values, stop accessions. Am I correct in interpreting some of the members?

DR. CASARETT: You say there are about 40,000 already in hand of all

types, $10,000 in others, I presume, and you have about up to 200,000 to go, and so you're --

CHAIRMAN MOSELEY: Yes.

MR. WHEELER: Well, of the 40,000 that we have left to go, there are archives of the Public Health Service, e.g., that are --

CHAIRMAN MOSELEY: They are available.

MR. WHEELER: -- that are accessible; they are available, many of which are duplicated within what we have collected. The 200,000 that he is talking about is a lot of specific records, and so forth that we don't really know where they are right now.

DR. WARRINER: I guess I never cease to be amazed at the controversy that the CIC engenders, seeing this with the other controversial topics that have been presented to the DAAG that have received minimal comment, but somehow the issue of document collection seems to be one that is rather exciting which, from the standpoint of an archivist, is fascinating to say the least. (Laughter)

I suppose though, the one thing I keep hearing of the comments that have been made so far is the issue of selectivity and specificity in prioritizing what it is that we collect, and what it is that we process. Documents that come to us come to us in one of two ways, and this might help answer some of this. Some of them have already been selectively reviewed. Those that are coming to us, one particular example, are those that came to us from the Department of Energy Headquarters Archives. Those documents were the result of a two year research process in the archives in the Department of Energy Headquarters. They have received extensive review. Some of them required extensive declassification review. When those came to us, we assumed that those had already been assigned a priority. There are other documents that the CIC Research Teams have

reviewed in other repositories. When we identify those documents, we only retrieve those that we feel are pertinent and that have a priority. There are others that come to us in bulk; what I presented to you yesterday, e.g., the Public Health Service Archives microfilm. Now that's 76 reels of microfilm. That, to identify of those 12,000 documents what it is that is most pertinent to us, will take some time. There is some prioritizing done within that study. The Research Team that put that collection together did review those documents and selected some 500 that they thought were the most pertinent documents for the records. Those would be the ones that we would put on our file initially. There are other documents in those 12,000, however, that we have used that have been requested, that we have provided, that are not among those 500. I suppose the problem that we all face is to set in a couple of criteria to distinguish between the ten cent, the one dollar, the $100, and the $10,000 document. What may appear to be a one dollar document today may be a $10,000 document tomorrow. I don't have a clear enough crystal ball to be able to predict which of those documents are going to fall in which category.

The other thing I want to say is that the CIC serves two functions, and I think that is often confused here. We serve as an information resource for the Task Groups of the ORERP. We serve also as an information resource both to the Department of Energy and any other agencies or members of the public that wish to use our resources; so that we are, in a sense, wearing two hats. It is perhaps the perspective of the DAAG to be most concerned with the dose assessment, and that is proper for you to be most concerned with that; but those of us who work in the CIC also have a broader conception of the function of the CIC in that we also want to provide services to a much broader public to be able to resolve the issues with which we are dealing. Obviously, the issue of the health effects of

ionizing radiation, the question of fallout, are controversial public issues, and we would like to resolve that controversy and provide public access to that information so at least there would be some public understanding of the issue.

MR. ZIMMERMAN: Maybe the question that might help us a little is what proportion of your budget do you think is being spent on servicing the litigation on the DOJ? What proportion is being spent on providing data to people other than the public and ORERP.

DR. WARRINER: I don't have those figures at my fingertips, Mike, but we could give you them --

MR. ZIMMERMAN: Just as a ballpark figure, would you say 5 percent, 20 percent, 50 percent?

DR. WARRINER: Well, obviously within the last seven months since the DAAG met last, because of the preponderance of the support by request relative to the legal effort -- and, Tom, you can correct me -- I would say probably 50 percent of our effort has been put to that for both plaintiffs and DOE at government lawyers' requests. That is doing research for people. That's not processing documents.

MR. ZIMMERMAN: So that comes out of your budget. You aren't reimbursed for that by any other planning source?

DR. WARRINER: That's right, it comes right out.

MR. ZIMMERMAN: The figure that we see, four hundred and some thousand dollars, really a large proportion of that is going for other then ORERP work?

DR. WARRINER: Correct.

CHAIRMAN MOSELEY: Did you want to say something?

DR. CAROTHERS: Yes, I want to say something. I have spoken from time to time in the past. I suppose I'm in the pro-CIC faction. I want to make

just one observation which may provide some perspective to this, although it's not necessarily relevant to the DAAG, and so on. The University of California, the Regents of the University of California, are currently named in some eight legal suits having to do with radiation health practices in the fifties. It is entirely conceivable that the discovery process involved in those legal suits will cost the University several million dollars.

I think that you have gotten a tremendous bargain out of the CIC in terms of overall monies that would have been spent in finding these documents in all of the places that they formerly resided.

CHAIRMAN MOSELEY: I don't know whether this comment has been made or not, but in actuality the genesis of the CIC had nothing to do with the Dose Assessment Advisory Group. It was required by other federal legislation that a communication and information center be established. It was established here in Las Vegas, and the Dose Assessment Advisory Group was given some relation to it for reasons that I don't totally understand at this point in terms of their advisory function, but there is specific separate legislation that establishes the CIC. Maybe our advice is gratuitous. In any case --

MR. FRADKIN: May I?

CHAIRMAN MOSELEY: Yes.

MR. FRADKIN: Again, my name is Philip Fradkin. If I could just say a few words as one who has to use the CIC extensively in doing research for my projects, I would hate to see anybody, whether they are the most knowledgeable person in the world, or the most menial clerk, deciding what I could see, because I don't know what I need until I see it myself. I think, to set somebody up within that system to select things out, you are putting one person's or two or three persons' biases in place where perhaps

there should be no bias, simply because, it strikes me, that not only this question you are discussing but the documentation that exists in the CIC, is the most extensive documentation that probably exists in this world on the effects of nuclear warfare, which is the most preeminent question of our time, and my project is only within the next couple of years. Well, I'm sure there will be historians, physicists, biologists, and so forth, who will be looking for the answers to these questions in any number of years, if we survive down the road, and I hope that this facility is given all the money and all the manpower it legitimately needs.

CHAIRMAN MOSELEY: Dr. McClellan.

DR. MC CLELLAN: Well, I think I've perhaps been one of the, I would hope, constructive critics of the Center. My concern is that today I can't tell you what it would cost to fulfill the objectives that have just been laid out, if those were adopted as the appropriate objectives for the Center.

My plea is for us to be provided information and some insight into the operations of the Center; some assurance that the limited resources that are available are being used to tackle the highest priority projects. Perhaps the information that might be provided might well lead us to endorse the request that would say the Center should receive $8 million to accomplish the total tasks at hand during the next year. Today we just don't have that kind of information.

In response to questions yesterday, we received extremely glib comments in terms of how many documents are potentially going to be entered, the status of key wording. We are simply not provided adequate information with regard to CIC to really render informed judgments on it. I think your problem, Bruce, is that you simply have not given us the information; and until you provide us the information, I think you will be on the yo-yo from

the Committee; because there are many things that we see in the CIC that we think are very laudatory. I think there are also impressions at times of some things that have to be accorded very low priority compared to other activities that we are reviewing; and we are reviewing some of these recognizing that they are operating under relatively severe budget contraints in getting important tasks done now.

MR. ZIMMERMAN: Mr. Chairman.

CHAIRMAN MOSELEY: Dr. Sarn, first.

DR. SARN: I, in the past, have favored the funding of the dose reconstruction of soil samples over the CIC, and I will admit to that. Of course, now that that problem seems solved with our really excellent work of the last couple of months, I would like to turn our attention to the CIC. In trying to be very practical and pragmatic, I think, number one, for Bruce's sake, I would favor continuing, obviously, the same level of effort that we are now expending. I think the second thing we really need out of the CIC is literally a list of those documents which they plan to register to put into the information bank with the amount of the resources they have at their disposal. I would also like to see a second category of information of what they would like to incorporate, or what they feel that they should incorporate. And, obviously, we need another contingency area in which there is going to be information developed that no one can foresee the need for such entry at this particular time. I think if that kind of information is presented to the DAAG group and also to Bruce that the decisions will be made much easier as to how much we are going to request in addition to make this CIC an appropriate one, because I think we must not lose sight of the fact that billions of dollars have been put into the development of nuclear weapons testing and millions of dollars into this effort to this point, and I would hate to see us somehow not

include that vital information into a repository someplace; but I don't think we can do it without having an idea of what we can do with the present resources, and what is left literally to be done.

CHAIRMAN MOSELEY: Mr. Zimmerman, can you educate this for me?

MR. ZIMMERMAN: Not likely. But I think it would be helpful along the lines that you mentioned, if we could get a budgetary breakdown of what your money is going for. I mean, you have only so much money, and people are saying, as I said, it is going to take you 15 years at the rate you are going. Now if you are spending half your money to support the lawsuits -- we don't look at, I think in terms of the ORERP, the comparison of a dollar spent on soil sampling versus a buck spent to help in the litigation. In other words, the money that funds that litigation is not really something we, I think we've been thinking we've been dealing with particularly, although it is recognized that you are spending time doing litigant assessments and that sort of stuff. Maybe it would be helpful if we got a projection of how much? It's going to cost you $3 million to support litigation for the next ten years? If so, are you going to have any money left to do the functions that at least some of us understood were the primary functions of CIC, which were to gather them so they wouldn't be lost or destroyed and make them available to the public and the ORERP. Maybe we should have some projections on that.

CHAIRMAN MOSELEY: Bruce, comments?

MR. CHURCH: Let me make a comment about what you just said, Mike, with respect to litigation. I fully anticipate restoration of that type of resource this year, and I fully anticipate that the litigation requirements are going to be dealt with on an agency-need basis and really not a problem for the DAAG to consider. I think the problem that DAAG needs to consider and be vitally interested in is the fact the resources and the mission of

the CIC satisfy the public needs; and I think that's what you need to focus on. We laid off six people this year, primarily at your suggestion, in that we interpreted your recommendation that we were doing too much in that arena for the sake of the public.

DR. MC CLELLAN: Hold it just a second. That, I think, is a gross misstatement, Bruce. Our recommendations come within the context of total dollars available. You could not make the statement you made without offering the qualification that the recommendation was made to provide dollars in terms of other activities. It's grossly inappropriate to make the statement in other context.

MR. CHURCH: And I'll back off to that degree, but the point is we're trying to operate in the context of providing enough resources into putting documents available to the public in harmony with the kind of recommendation that you guys have given us.

CHAIRMAN MOSELEY: I had made the assumption that we might be able to do this by correspondence between now and the next meeting, and as the discussion has gone on it is apparent to me that's not a feasible mechanism for responding to this.

Can you stand to ride up and down the yo-yo until May, Bruce, so that we might at the next meeting of this committee bring joy to the archivist's heart and devote substantial time yet again to investigating our feelings about the CIC and our recommendations.

MR. CHURCH: We will do the best we can. One thing you might consider is maybe a subcommittee of three can meet with us in a month or two and look at it in excruciating detail.

CHAIRMAN MOSELEY: I will be glad to form such a subcommittee, and I think that is probably a good idea because I don't think the whole committee can look at it in the detail that is required, but there is a

substantial amount of disagreement on this Advisory Group. I don't know exactly how to get you a representative committee. Maybe you would choose the people from the assessment group that you would like to serve on that committee. (Laughter)

MR. CHURCH: I would prefer not to.

DR. CAROTHERS: This raised hand is not to volunteer --

CHAIRMAN MOSELEY: Oh, thank you very much.

DR. CAROTHERS: -- but I would like, if I may, to have a couple of minutes?

CHAIRMAN MOSELEY: Yes.

DR. CAROTHERS: I would like to address a question to Mr. Warriner. At one time, sir, you typified your collection as a manuscript collection rather than as an archives. Would you consider that to be true today?

DR. WARRINER: Yes.

DR. CAROTHERS: Now my understanding is that in a manuscript collection, basically every document or manuscript is indexed individually and separately. Is that your practice in your operation?

DR. WARRINER: Yes.

DR. CAROTHERS: I will point out to the committee that that is an enormously costly way to do business in terms of time, effort, and money. It provides you with the finest possible index because every single piece of paper is indexed onto your data base, and you can find it, hopefully, relatively easily by one method or another. There are other ways of indexing which are not so laborious and costly, all-be-it-not so, that don't provide the same facility for retrieval to people, such as Mr. Fradkin, who wish to do research.

Have you investigated that possibility and rejected it?

MR. NUTLEY: Yes.

DR. CAROTHERS: Is there a reason for that?

MR. NUTLEY: The decision was made before Mr. Warriner came on board that we had to be able to recover each individual document on its own merit rather than a group of documents of similar subject matter.

DR. CAROTHERS: Is that directive or decision arguable?

MR. NUTLEY: Certainly.

DR. CAROTHERS: Because if it is not, then I submit that there is no point in further discussion.

MR. NUTLEY: We can discuss anything that needs to be discussed.

DR. CAROTHERS: I know, but I do not wish to discuss something which leads to no possible action, however. I do that at home a lot. I don't wish to do it here. (Laughter)

MR. NUTLEY: Is your wife related to mine?

DR. CAROTHERS: No, but the point I'm making is that if it is in some form of an order from somebody that we must follow regardless, why then so be it. It's just a point that might be investigated by this subcommittee, sir.

CHAIRMAN MOSELEY: Yes.

DR. MC CLELLAN: Let me try to be as succinct as I can. What I would like to see -- my concern is that we don't have enough information at hand to really grapple with the CIC. I would like to see laid out before us what are the absolute norms in terms of documents that are in hand today be it perhaps categorized by three value ranges. I think even the member of the public who spoke would agree that it would be appropriate to input certain resources. If you can't do them all tomorrow, instantaneously, you have to have some decision basis to which you will do first. But if we had that as a given there, we had the information in hand in terms of how many have been keyworded, how many have not; what is the average amount of time

required to just index a document, enter it in; what is the amount of time projected to keyword it, and a management plan -- to carry out other functions of the Center, and then a management plan laid out for the next one, two, three, five years; so that we are not based on essentially a kind of a level of effort. What we keep hearing is, we don't have enough money to do the task. Well, we will never get it solved unless we can have a certain number of givens put on the table and some assumptions. You've got to make them, i.e., we assume we will get another 10,000 documents of this kind. But a plan. We've got to see a plan if we are going to grapple with this, then we can react to the plan.

CHAIRMAN MOSELEY: I don't believe that we are going to solve this this afternoon, and the committee is peeling off to the airport at an accelerating rate; so the Chair will appoint a subcommittee of this committee to grapple with this problem before the next meeting of the Dose Assessment Advisory Group in May. I think we will have to have that subcommittee report to the full committee in May, so the yo-yo will have to go up and down or maybe spin at the bottom for awhile.

Now aren't you sorry you brought that up and interrupted me, Bruce, when I was adjourning the meeting which I do so at this time.

(Whereupon, the meeting was adjourned at 3:40 p.m. to reconvene at 8:30 a.m. on May 19, 1983.)

STATE OF NEVADA)
) SS: CERTIFICATE OF REPORTERS
COUNTY OF CLARK)

I, FRANCES ANSON, Verbatim Reporter, hereby certify that I took down in shorthand, and I, BROOKEE ALLEN, C.S.R. #5, do hereby certify that I took down in shorthand (stenotypy), the proceedings had in the above-entitled matter; and

I, FRANCES ANSON, do further certify that my shorthand notes, in conjunction with voice tapes, were transcribed into typewriting: Volume I, pages 1 through 110; 311 through 351; and Volume II, pages 141 through 193, line 14; and

I, BROOKEE ALLEN, do further certify that my shorthand notes, in conjunction with voice tapes, were transcribed into typewriting: Volume I, pages 111 through 310; 352 through 416; and Volume II, pages 1 through 140; and 193, line 15 through 302; the above pages inclusive of viewgraphs associated therewith.

We, FRANCES ANSON and BROOKEE ALLEN, do further certify that the foregoing pages contain a full, true and correct transcription of all of the proceedings had at the said time and place and that the foregoing transcript is a true record of said proceedings to the best of our skill and ability.

Dated at Las Vegas, Nevada, this 25th day of February, 1983.

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