NRC FORM 374
(7-94)

U.S. NUCLEAR REGULATORY COMMISSION

Amendment No. 23

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. U. S. Environmental Protection Agency National Exposure Research Laboratory Characterization Research Division 2. P.O. Box 93478 Las Vegas, NV 89193-3478	In accordance with application dated October 18, 1996, 3. License Number: 27-05861-02 is amended in its entirety to read as follows: 4. Expiration Date: February 28, 2007 5. Docket or Reference No.: 030-06981

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
A. Hydrogen-3	A. Any	A. 5 millicuries
B. Any byproduct material with Atomic Nos. 3-83, and with half-lives less than or equal to 120 days	B. Any	B. Not to exceed 5 millicuries per radionuclide
C. Any byproduct material with Atomic Nos. 3-83 with half-lives greater than 120 days	C. Any	C. Not to exceed 1 millicurie per radionuclide and 25 millicuries total
D. Any byproduct material with Atomic Nos. 3-83	D. Sealed and/or plated sources	D. Not to exceed 5 millicuries per source and 100 millicuries total
E. Carbon-14	E. Any	E. 10 millicuries
F. Strontium-90	F. Any	F. 200 microcuries
G. Iodine-129	G. Any	G. 50 microcuries
H. Any byproduct, source or special nuclear material with Atomic Nos. 84-96	H. Any	H. Not to exceed 100 microcuries per radionuclide and 10 millicuries total

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License Number 27-05861-02

Docket or Reference Number 030-06981

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Amendment No. 23

(continued)

I.	Any byproduct, source or special nuclear material with Atomic Nos. 84-96	I.	Sealed and/or plated sources	I.	Not to exceed 100 microcuries per source and 10 millicuries total
J.	Polonium-210	J.	Any	J.	650 microcuries
K.	Uranium-233	K.	Any	K.	10 microcuries
L.	Uranium-235	L.	Any	L.	10 microcuries
M.	Plutonium-236	M.	Any	M.	10 microcuries
N.	Plutonium-238	N.	Any	N.	60 microcuries
O.	Plutonium-239	O.	Any	O.	30 microcuries
P.	Plutonium-240	P.	Any	P.	10 microcuries
Q.	Plutonium-241	Q.	Any	Q.	10 microcuries
R.	Plutonium-242	R.	Any	R.	10 microcuries
S.	Plutonium-244	S.	Any	S.	5 microcuries
T.	Source material	T.	Any	T.	15 pounds
U.	Nickel-63	U.	Foils or plated sources in detector cells	U.	1 curie
V.	Cesium-137	V.	Sealed source (U.S. Nuclear Model 375)	V.	1 millicurie
W.	Cobalt-60	W.	Sealed source (U.S. Nuclear Model 375)	W.	5 millicuries
X.	Cesium-137	X.	Sealed source (U.S. Nuclear Model 375)	X.	300 millicuries
Y.	Cesium-137	Y.	Sealed source (New England Nuclear Model NER-572)	Y.	10 millicuries

License Number 27-05861-02

Docket or Reference Number 030-06981

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Amendment No. 23

(continued)

Z. Cesium-137	Z. J. L. Shepherd and Associates Series 6810 sealed sources (Reference Dwg. No. A-0348 dated July 24, 1976)	Z. Six sources consisting of the following activities: 10 curies, 1 curie, 100 millicuries, 10 millicuries (2 sources) and 1 millicurie
AA. Plutonium-239	AA. Sealed or plated sources	AA. Not to exceed 5 microcuries per source and 100 microcuries total
BB. Hydrogen-3	BB. Titanium tritide foils in detector cells	BB. 5 curies
CC. Cesium-137	CC. Sealed source	CC. 100 millicuries
DD. Cesium-137	DD. Sealed source (Amersham Model CDC.711M Series)	DD. Not to exceed 3 curies per source and 6 curies total
EE. Cesium-137	EE. Sealed sources (NEN Model G316 B capsule and a J.L. Shepherd and Associates Type 6810 capsule, both reencapsulated in one source holder)	EE. 751 millicuries
FF. Americium-241	FF. Sealed sources (Amersham Model AMC.D2)	FF. Not to exceed 30 millicuries per source and 60 millicuries total
GG. Curium-244	GG. Sealed sources (Amersham Model CLCL or Isotope Products Model XFB series)	GG. Not to exceed 100 millicuries per source and 200 millicuries total

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number 27-05861-02

Docket or Reference Number 030-06981

Amendment No. 23

9. Authorized Use

A. through T. To be used in laboratory and tracer studies and analysis; development and standardization of chemical procedures; instrument calibration; research and development as defined in 10 CFR Part 30.4; preparation and distribution of radioanalysis calibration standards and environmental-level laboratory intercomparison samples; and the local fabrication of subnanocurie electrodeposited sources for calibrations. Sealed sources may also be used for demonstration and training purposes in the laboratory and field. Studies in animals are not authorized.

U. To be used in gas chromatographs for sample analysis.

V. and W. To be used in J. L. Shepherd Model 28-5 devices for instrument calibration.

X. To be used in J. L. Shepherd Model 142-10 irradiator for instrument calibration.

Y. For storage only in a Mount Sopris Model 1000-C Portable Borehole Logger.

Z. For use in two concrete shielding wells for instrument and dosimetry calibration.

AA. For instrument calibration.

BB. To be used in gas chromatographs for sample analysis.

CC. For use in a panoramic device for calibration of TLDs and pocket dosimeters.

DD. To be used in a Williston Elin self shielding TLD irradiator to irradiate Panasonic TLDS.

EE. To be used in a J.L. Shepherd Model 89 Series Calibrator within a J.L. Shepherd Model 78 Series Self-Contained Calibration Facility for instrument calibration.

FF. and GG. To be used in Columbia Scientific Industries Corp. portable X-ray analyzer Model 880 for analysis of metal contaminants in soil and ground water.

CONDITIONS

10. Licensed material may be stored at the licensee's warehouse at 3201 Sunrise Avenue, #103, Las Vegas, Nevada, and shall be used only at the licensee's facilities located at 944 East Harmon Avenue, Las Vegas, Nevada or the Department of Energy's Nevada Test Site, 65 miles northwest of Las Vegas, except:

    A. Sealed sources listed in Subitems B. through U. may be used for instrument calibration at the licensee's facilities at 4220 South Maryland Parkway, Building C; Las Vegas, Nevada.

    B. Sealed sources listed on this license which have individual activities less than those listed in Schedule B of 10 CFR 30.71, or those sealed sources listed in Subitems A through T., may be used for instrument calibration, demonstration, or training at temporary job sites of the licensee anywhere in the United States.

    C. Sealed sources listed in Subitems Z. and CC. may be used only at the licensee's facilities at 944 East Harmon Avenue, Las Vegas, Nevada.

    D. Sealed sources listed in Subitem W. and EE. may be used for instrument calibration at temporary job sites of the licensee anywhere in the United States.

    E. Sealed sources listed in Subitems FF. and GG. may be used for soil and ground water analysis at temporary job sites of the licensee anywhere in the United States.

11. A. Licensed material shall only be used by, or under the supervision of, individuals designated by the Radiation Safety Committee, Stephen H. Pia, Chairperson.

    B. The Radiation Safety Officer for this license is Loyd D. Carroll.

12. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

    B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

12. (Continued)

C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

D. Each sealed source fabricated by the licensee shall be inspected and tested for construction defects, leakage, and contamination prior to any use or transfer as a sealed source.

E. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

(iv) they contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

F. The leak test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30(b)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. The report shall be filed within 5 days of the date the leak test result is known with the U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, ATTN: Director, Division of Radiation Safety and Safeguards. The report shall specify the source involved, the test results, and corrective action taken.

G. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically licensed by the Commission or an Agreement State to perform such services.

13. Sealed sources or detector cells containing licensed material shall not be opened or sources removed from source holders by the licensee.

14. Maintenance, repair, cleaning, replacement and disposal of foils contained in detector cells shall be performed only by the device manufacturer or other persons specifically authorized by the Commission or an Agreement State to perform such services.

15. Detector cells containing a titanium tritide foil or a scandium tritide foil shall only be used in conjunction with a properly operating temperature control mechanism which prevents the foil temperature from exceeding that specified by the manufacturer and approved by NRC.

16. Each source holder or logging tool containing radioactive material shall bear a legible and visible marking as specified in 10 CFR 39.31(a). The label must be on the smallest component that contains the licensed material which is transported as a separate piece of equipment.

17. The licensee shall not use licensed material in or on human beings except as provided otherwise by specific condition of this license.

18. The licensee shall not use licensed material in field applications where activity is released except as provided otherwise by specific condition of this license.

19. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under the license.

20. The licensee is authorized to transport licensed material only in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

21. In addition to the possession limits in Item 8, the licensee shall further restrict the possession of unsealed licensed material or readily dispersible source material to quantities less than 10^5 times the applicable limits in Appendix B of 10 CFR Part 30, and 10 mCi of dispersible source material as specified in 10 CFR 30.35, 40.36, and 70.25.

22. Notwithstanding the requirements of 10 CFR 20.1501(c), the licensee may use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number 27-05861-02

Docket or Reference Number 030-06981

Amendment No. 23

23. The licensee is authorized to hold radioactive material with a physical half-life of less than 70 days for decay-in-storage before disposal in ordinary trash provided:

A. Radioactive waste to be disposed of in this manner shall be held for decay a minimum of 10 half-lives.

B. Before disposal as ordinary trash, byproduct material shall be surveyed at the container surface with the appropriate meter set on its most sensitive scale and with no interposed shielding to determine that its radioactivity cannot be distinguished from background. All radiation labels shall be removed or obliterated.

C. A record of each disposal permitted under this License Condition shall be retained for 3 years. The record must include the date of disposal, the date on which the byproduct material was placed in storage, the radionuclides disposed, the survey instrument used, the background dose rate, the dose rate measured at the surface of each waste container, and the name of the individual who performed the disposal.

24. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Letter dated July 3, 1996
B. Letter dated September 19, 1996
C. Application dated October 18, 1996
D. Letter dated February 18, 1997

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date FEB 25 1997

By Beth A. Prange
Materials Branch
Region IV, WCFO
Walnut Creek, California 94596

ORC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

FEB 25 1997

U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division
ATTN: John M. Moore
Acting Director
P.O. Box 93478
Las Vegas, Nevada 89193-3478

SUBJECT: LICENSE RENEWAL

Please find enclosed License No. 27-05861-02. You should review this license carefully and be sure that you understand all conditions. If you have any questions, you may contact the reviewer who signed your license at (510) 975-0250.

NRC expects licensees to conduct their programs with meticulous attention to detail and a high standard of compliance. Because of the serious consequences to employees and the public which can result from failure to comply with NRC requirements, you must conduct your program involving radioactive materials in accordance with the conditions of your NRC license, representations made in your license application, and NRC regulations. In particular, note that you must:

1. Operate in accordance with NRC regulations 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," 10 CFR Part 20, "Standards for Protection Against Radiation," and other applicable regulations.

2. Possess radioactive material only in the quantity and form indicated in your license.

3. Use radioactive material only for the purpose(s) indicated in your license.

4. Notify NRC in writing of any change in mailing address (no fee required if the location of radioactive material remains the same).

5. Request and obtain written NRC consent before transferring your license or any right thereunder, either voluntarily or involuntarily, directly or indirectly, through transfer of control of your license to any person or entity. A transfer of control of your license includes not only a total change of ownership, but also a change in the controlling interest in your company whether it is a corporation, partnership, or

other entity. In addition, appropriate license amendments must be requested and obtained for any other planned changes in your facility or program that are contrary to your license or contrary to representations made in your license application, as well as supplemental correspondence thereto, which are incorporated into your license. A license fee may be charged for the amendments if you are not in a fee-exempt category.

6. Maintain in a single document decommissioning records that have been certified for completeness and accuracy listing all the following items applicable to the license:

   - Onsite areas designated or formerly designated as restricted areas as defined in 10 CFR 20.3(a)(14) or 20.1003.

   - Onsite areas, other than restricted areas, where radioactive materials in quantities greater than amounts listed in Appendix C to 10 CFR 20.1001-20.2401 have been used, possessed, or stored.

   - Onsite areas, other than restricted areas, where spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site have occurred that required reporting pursuant to 10 CFR 30.50(b)(1) or (b)(4), including areas where subsequent cleanup procedures have removed the contamination.

   - Specific locations and radionuclide contents of previous and current burial areas within the site, excluding radioactive material with half-lives of 10 days or less, depleted uranium used only for shielding or as penetrators in unused munitions, or sealed sources authorized for use at temporary job sites.

   - Location and description of all contaminated equipment involved in licensed operations that is to remain onsite after license termination.

7. Submit a complete renewal application with proper fee, or termination request at least 30 days before the expiration date on your license. You will receive a reminder notice approximately 90 days before the expiration date. Possession of radioactive material after your license expires is a violation of NRC regulations.

8. Request termination of your license if you plan to permanently discontinue activities involving radioactive material.

You will be periodically inspected by NRC. Failure to conduct your program in accordance with NRC regulations, license conditions, and representations made in your license application and supplemental correspondence with NRC will result in enforcement action against you. This could include issuance of a notice of violation; imposition of a civil penalty; or an order suspending, modifying, or revoking your license as specified in the "General Statement of Policy and Procedure for NRC Enforcement Actions" (Enforcement Policy), 60 FR 34381, June 30, 1995.

Thank you for your cooperation.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Docket: 030-06981
License: 27-05861-02
Control: 571951

Enclosures: As stated

bcc:

Docket File
WCFO Inspection File
LFDCB, T-9 E10
State of NV (License Only)

DOCUMENT NAME: G:\beth\571951

To receive copy of document, indicate in box: "C" = Copy without enclosures "E" = Copy with enclosures "N" = No copy

RIV:MB	N	C:MB							
BPrange BAP		FWenslawski							
02/25/97		02/ /97		02/ /97		02/ /97		02/ /97	

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

RECEIVED
NRC
RIV WCFO
97 FEB 21 AM 11:02

OFFICE OF
RESEARCH AND DEVELOPMENT

February 18, 1997

U. S. Nuclear Regulatory Commission Region IV
Walnut Creek Field Office
Attention: Materials and Licensing Branch (Ms. Prange)
1450 Maria Lane
Walnut Creek, California 94596-5368

Reference: License No 27-05361-02
Docket No. 030-06981
Control No. 571951

Dear Ms. Prange:

The purpose of this letter is two-fold; first, to inform you of personnel changes in management and secondly, to provide information which you had previously requested.

a. As Acting Director, I replaced Wayne N. Marchant, the previous Director who retired on January 3, 1997. I have appointed Richard L. Garnas as the management representative on the CRD-LV Radiation Safety Committee.

b. On October 31, 1996, you telephonically requested from our RSO additional information to supplement our most recent NRC license renewal application request, dated October 18, 1996. The following information has been approved by our Radiation Safety Committee and is provided per your request.

1. Audit Program. Audits and the review of the content and implementation of the radiation safety program are the responsibility of management. Management may fulfill this responsibility either by having audits conducted by the CRD-LV RSC, Quality Assurance Manager, or by contracting with an independent auditor to review the program. Periodic audits will be performed at least annually and will include the review of all Authorized Users and the RSO. The auditor's results will be presented to the RSC for formal review and action. Additional audit/review information can be found in our most recent NRC license renewal application request, Item 10, paragraphs A (Authorization to use radioactive materials), pages 11-12 and F (ALARA program), pages 30-34. All audit reports and records will be maintained by the RSO.

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2. Organizational chart. This revised chart (Enclosure #1) annotates the organizational scheme of the RSO and RSC.

3. Responsibilities of the Alternate RSO. The purpose of the Alternate RSO is to act in behalf of the RSO whenever the RSO is absent or on leave (for a period up to 2/3 weeks). It is not intended that the Alternate RSO perform the duties of the RSO. Whenever the RSO is not available, the Alternate RSO should be available for consultations, emergencies, inspections, etc. The RSO will be present at all Radiation Safety Committee meetings and will perform all assigned RSO duties; these duties will not be performed by the Alternate RSO when the RSO is available.

4. Contamination levels. Please reference the Table "Acceptable Surface Contamination Levels for the Uncontrolled Release of Equipment" on page 21 of our most recent NRC license application request. Please delete the last entry in this table, specified as "Tritium organic compounds, HT, HTO, and metal tritide aerosols", and the two corresponding contamination levels annotated as "10,000" as these two contamination levels for this entry are too high.

5. Mobile Gas Chromatograph (GC) units with titanium tritide foil or scandium tritide foil detector cells. Currently, we have two such GCs (each having a 300 mCi H-3 sealed source) which were procured under our NRC license. To date, these units have not been used in the field. If and when these units are used in the field, a tedlar bag with a luer fitting (self-closing valve) or a similar collecting bag will be connected to the unit's exhaust port for the purpose of collecting the expelled gas. The collectant will be transported back to our facilities and released in a fume hood. Please make appropriate changes to paragraph L1f(2) on page 41 of our most recent NRC license renewal application request to accommodate this requirement.

6. Instrument Calibrations. EPA personnel perform calibrations on equipment and radiation instrumentation belonging to EPA and also used for Federal Radiological Monitoring and Assessment Center events and training exercises. We normally do not provide calibration services for other licensees.

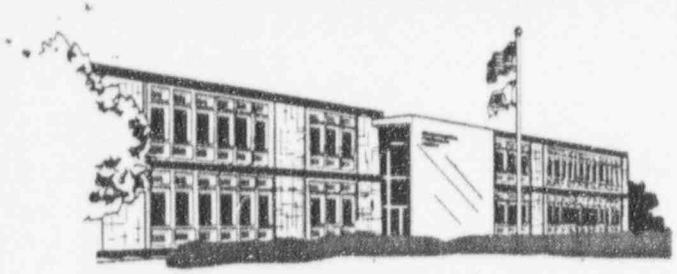
Call the RSO at (702) 798-2313 for any questions.

Sincerely,

John M. Moore

John M. Moore
Acting Director,
Characterization Research Division

Enclosure



EPA

U.S. Environmental Protection Agency
National Exposure Research Laboratory
702/798-2100

Characterization Research Division - Las Vegas

Radiation Safety Committee

Radiation Safety Officer

Office of the Director

John M. Moore, Acting Director

702/798-2522/2525
FAX: 702/798-2233

ODC *Lorraine Payne (2525)*

Program Operations Staff

Richard L. Garnas, Acting Director
702/798-2235
FAX: 702/798-2380

POS *Liz Sutton (2564)*

Analytical Sciences Branch

Christian G. Daughton, Acting Chief
702/798-2207
FAX: 702/798-2261

ASB *Marilyn Janunas (2609)*
Jan Contreras (2383)

Monitoring Sciences Branch

Robert D. Schonbrod, Acting Chief
702/798-2229
FAX: 702/798-2692

MSB *Joann Menke (2237)*

Research Areas

- Immunoassay/Biosensors
- Groundwater
- UST
- Surface/Subsurface Characterization
- Human Exposure
- Analytical Methods
- QA Research
- Field Methods
- Technical Support Center
- SITE Program
- Consortium for Site Characterization Technologies
- Drinking Water Rad QA

Research Areas

- Non-point Sources
- Global Climate Research
- Landscape Ecology
- Landscape Characterization
- Wildlife Indicators
- Habitat/Biodiversity
- Remote Sensing Research
- Remote Sensing Support
- Spatial Information Sciences

Co-Located Units

Radiation & Indoor Environments - LV

Jed Harrison
Director

R&IE *702/798-2476*

Office of Civil Rights

Pat A. McKenzie
Area Director

OCR *702/798-2512*

Human Resources Staff - LV

Millicent S. Dilworth
Sheron E. Johnson
Acting Co-Directors

HRS *702/798-2414*

Financial Management Center

Alan B. Lewis
Financial Manager

FMC *702/798-2485*

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U.S. NUCLEAR REGULATORY COMMISSION
REGION V

TELEPHONE OR VERBAL CONVERSATION RECORD (MS-15)

DATE ~~00/00/00~~ 10/31/96

TIME 10:30 ~~00:00~~ (am)/pm

[ ] INCOMING CALL [ ] OUTGOING CALL [ ] VISIT

PERSON CALLING:	OFFICE/ADDRESS:	PHONE NUMBER:

PERSON CALLED:	OFFICE/ADDRESS:	PHONE NUMBER:
Loyd Carroll	EPA, LV, RSO	(702) 798-2313

CONVERSATION

SUBJECT - Submittal of 10/18/96

SUMMARY -

1.) AUDITS + RSC Participation

- Describe the audit program for laboratories. Items described in Enclosure 20 are the types of concerns of interest.

  The RSO said these audits are conducted + are reported to the RSC. He will submit a description.

- It was noted that the RSC's involvement, as described in the application, was only a paperwork review. The broad-scope guide, p. 23, states that members of the RSC should accompany during audits. The RSC involvement should be reconsidered.

2.) Organization

Please submit an organizational chart. Indicate RSC members with asterisks or other such notation.

REFERRED TO:	[ ] ADVISE ME ON ACTION TAKEN
ACTION REQUESTED:	INITIALS:
	DATE:
ACTION TAKEN:	INITIALS:
	DATE:

NRC FORM 218 REV-0 8/93 [WP/Ldc-RIV]

U.S. NUCLEAR REGULATORY COMMISSION
REGION V

TELEPHONE OR VERBAL CONVERSATION RECORD

DATE 00/00/00

TIME 00:00 am/pm

[ ] INCOMING CALL [ ] OUTGOING CALL [ ] VISIT

PERSON CALLING:	OFFICE/ADDRESS:	PHONE NUMBER:
PERSON CALLED:	OFFICE/ADDRESS:	PHONE NUMBER:

CONVERSATION

SUBJECT -

SUMMARY -

3.) Asst, RSO

Read standard condition to RSO. We may need to change "one month" to "two weeks."

4.) Contamination levels

p.21 of application — H-3 levels are not acceptable. If B, γ levels are exceeded, approval must be obtained on a case-by-case basis. O.K. They will strike this item.

5.) Gas Chromatograph Venting

Are H-3 g.c.'s used in mobile applications? RSO will check this. Do not vent H-3 g.c.s in mobile units to outside. We may need to change the license condition. Look at p.41 of manual. Will check + call back.

REFERRED TO:	[ ] ADVISE ME OF ACTION TAKEN
ACTION REQUESTED:	INITIALS:
	DATE:
ACTION TAKEN:	INITIALS:
	DATE:

NRC FORM 218 REV-0 8/93 [WP/bdc-RIV]

U.S. NUCLEAR REGULATORY COMMISSION
REGION V

TELEPHONE OR VERBAL CONVERSATION RECORD

DATE 00/00/00

TIME 00:00 am/pm

[ ] INCOMING CALL [ ] OUTGOING CALL [ ] VISIT

PERSON CALLING:	OFFICE/ADDRESS:	PHONE NUMBER:
PERSON CALLED:	OFFICE/ADDRESS:	PHONE NUMBER:

CONVERSATION

SUBJECT -

SUMMARY -

6.) Instrument calibration

Verified that EPA calibrates their own instruments. This is not a customer - service operation.

7.) DOELAP issue

Exemption has not been approved. The renewal cannot be issued until HQRS replies.

- B. Prange

REFERRED TO:

[ ] ADVISE ME ON ACTION TAKEN

ACTION REQUESTED:

INITIALS:

DATE:

ACTION TAKEN: RSO called back at 1:45pm on 10/31/96. The researcher said H-3 g.c.s are used in-house, but may be used in the field in the future.

INITIALS: BAP

DATE:

NRC FORM 218 REV-0 8/93 [WT/bdc-RIV]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.C. BOX 93478 • LAS VEGAS, NV 89193-3478

96 OCT 21 AM 9:48

OFFICE OF
RESEARCH AND DEVELOPMENT

October 18, 1996

US Nuclear Regulatory Commission, Region IV
Walnut Creek Field Office
Attention: Ms. Beth Prange (Licensing and Materials Branch)
1450 Maria Lane
Walnut Creek, California 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981
Control No. 571951

Subject: NRC Material License Renewal Application Request

Dear Ms. Prange:

Attached for your approval is NRC Form 313 for our latest NRC material license renewal application request. This request supersedes the previous request dated April 3, 1996, which superseded the original request dated February 11, 1994. The substance of this application is our approved Radiation Safety Manual, which is referenced in the application. This is the same manual that was included in our original request in 1994.

A revised Statement of Intent for decommissioning funding is being sent to you separate from this request.

If I can be of assistance, please call me at (702) 798-2525.

Sincerely,

Wayne N Marchant

Wayne N. Marchant
Director, Characterization Research Division

Attachment

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (40% Postconsumer)

571951

NRC FORM 313 (6-93)
10 CFR 30, 32, 33
34, 35, 36, 39 and 40

U. S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIAL LICENSE

APPROVED BY OMB: NO. 3150-0120
EXPIRES 6-30-96

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 9 HOURS. SUBMITTAL OF THE APPLICATION IS NECESSARY TO DETERMINE THAT THE APPLICANT IS QUALIFIED AND THAT ADEQUATE PROCEDURES EXIST TO PROTECT THE PUBLIC HEALTH AND SAFETY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0120), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

LICENSING ASSISTANT SECTION
NUCLEAR MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION II
101 MARIETTA STREET, NW, SUITE 2900
ATLANTA, GA 30323-0199

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137-5927

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TX 76011-8064

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

RADIOACTIVE MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION V
1450 MARIA LANE
WALNUT CREEK, CA 94596-5368

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S.NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [ ] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER _____
- [X] C. RENEWAL OF LICENSE NUMBER 27-05861-02

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip code)*

US Environmental Protection Agency
National Exposure Research Laboratory (NERL)
Characterization Research Division (CRD-LV)
P.O. Box 93478
Las Vegas, Nevada 89193-3478

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

US Environmental Protection Agency
Office of Research and Development
NERL, CRD-LV
944 East Harmon Avenue
Las Vegas, Nevada 89119

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Loyd Carroll, RSO

TELEPHONE NUMBER

(702) 798-2313

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5.	RADIOACTIVE MATERIAL. a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.	6.	PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7.	INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.	8.	TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9.	FACILITIES AND EQUIPMENT.	10.	RADIATION SAFETY PROGRAM.
11.	WASTE MANAGEMENT.	12.	LICENSEE FEES *(See 10 CFR 170 and Section 170.31)* FEE CATEGORY / AMOUNT ENCLOSED $ N/A

13. CERTIFICATION *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39 AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER – TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Wayne N. Marchant, Director	Wayne N Marchant	October 18, 1996

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

PRINTED ON RECYCLED PAPER

Item 5. Radioactive material.

There are no changes in the radionuclides, forms, and amounts currently authorized in our NRC License.

Item 6. Purposes for which licensed material will be used.

There are no changes for purposes for which licensed material will be used from those currently authorized. The administration of radioactive materials or radiation to or in animals or humans is not performed, nor authorized.

Item 7. Individuals responsible for the Radiation Safety Program and their training experience.

A. Senior Management. The Director, Characterization Research Division - Las Vegas (CRD-LV), has overall responsibility for the radiation safety program. He will establish a Radiation Safety Committee and appoint a Radiation Safety Officer (RSO) and a management representative to ensure that the requirements in CRD-LV's operating procedures, NRC license, amendments, associated documents and regulations are implemented, followed and enforced.

B. Radiation Safety Committee (RSC). As an advisory body to the Director, the RSC is responsible for the administration and enforcement of CRD-LV's radiation safety program to ensure that radioactive materials and sources of ionizing radiation are used safely and that radiation exposures to workers and the public are maintained at levels that are As Low As Reasonably Achievable (ALARA).

1. The membership includes the representative from management, the RSO, persons trained and experienced in the safe use of radioactive materials (Authorized Users for Nonmedical Use), and other personnel deemed as appropriate. Appointments are made by the Director. There are currently 16 members (12 are Users); each member has one vote. The management representative is John Moore, RSO is Loyd Carroll, Alternate RSO is Gregg Dempsey, and Chairperson is Stephen Pia. Refer to Enclosures 1-5 for pertinent experience for the RSO, Alternate RSO, and Chairperson. Authorized Users and Co-Authorized Users have training equivalent to that specified in 10 CFR 33.15(b)(1) and (2) and, in addition to workers, receive training in accordance with 10 CFR 19.12. Co-Authorized Users assume the responsibilities of the Authorized User in the absence of the User.

2. The RSC shall:

(a) Be familiar with the subject matter in CRD-LV's Radiation Safety Manual, applicable NRC rules and regulations,

the NRC license, amendments and all associated documents;

(b) Establish and implement written policy and procedures for the production, procurement, receipt, possession, storage, usage, transfer, disposal and shipment of radioactive materials and equipment that produces ionizing radiation;

(c) Review the training and experience of the proposed authorized users and the RSO to determine that their qualifications are sufficient to enable the individuals to perform their duties safely and are in accordance with applicable regulations and the license;

(d) Review on the basis of safety and approve or deny, consistent with the limitations of applicable regulations, the license and the ALARA philosophy, all requests for authorization to use radioactive materials or radiation sources;

(e) Prescribe special conditions that will be required during a proposed method of use of radioactive material such as, but not limited to, requirements for bioassay and special monitoring procedures;

(f) Establish a training and educational program to ensure that individuals are trained as required by 10 CFR 19.12;

(g) Review the RSO's quarterly summary report of the occupational radiation exposure data of personnel and establish occupational exposure investigational levels which, when exceeded, will initiate a prompt investigation by the RSO to determine the cause of the exposure and, if required, initiate corrective action to reduce the probability of recurrence;

(h) Review at least annually the RSO's summary report of the entire radiation safety program to determine that all activities are being conducted safely, in accordance with NRC regulations and the conditions of the NRC license, and consistent with the ALARA program and philosophy. The review must include an examination of records, reports from the RSO, results of NRC inspections, written safety procedures, and the adequacy of the management control system;

(i) Review all incidents involving radioactive materials or other sources of ionizing radiation with respect to the cause and subsequent actions taken; and

(j) Ensure that the NRC license is amended when required, prior to any changes in radionuclides and activities, facilities, equipment, policies, procedures and personnel.

3. Meetings and documentation.

(a) The RSC shall meet at least quarterly and at any other time at the request of the representative from management or the Chairperson.

(b) To establish a quorum and to conduct business, at least one-half of the membership must be present, including the RSO and the representative from management.

(c) The minutes shall be written, dated, and include the attending and absent members, a summary of deliberations and discussions, recommended actions, and the numerical ballot results. The minutes shall be provided to each member and one copy retained for the duration of the license.

C. Radiation Safety Officer (RSO) or Alternate RSO. The RSO is a full-time federal employee and the position is a part-time assignment (minimum of 50%). There is no radiation safety staff to support the RSO. The RSO is currently assigned to the Analytical Sciences Branch (ASB), reports to the Branch Chief, and performs assigned duties as required. Senior management supports the RSO, who has access to all levels of the organization, and the authority to immediately terminate any activity that is found to be a threat to public health, safety, or property. The RSO is available 24 hours/day. The RSO's telephone number is on the emergency notification roster and the RSO is issued a pager. The Alternate RSO will perform the duties of the RSO during the RSO's absence.

1. The RSO is responsible for the implementation and enforcement of the radiation safety program. Temporary minor exceptions to specific provisions of the Radiation Safety Manual may be granted by the RSO on an individual basis, providing such exceptions do not jeopardize individual safety or violate the NRC license, conditions, and associated documents, and rules and regulations for the use of radioactive materials or equipment that produces ionizing radiation.

2. The RSO shall:

(a) Advise the Director, RSC, and workers of radiation safety hazards and on the control of radioactive materials and other sources of ionizing radiation;

(b) Maintain, as custodian of all radioactive materials, a current inventory of all radioactive materials from their receipt to their ultimate disposal or transfer;

(c) Ensure that portable survey instruments used for monitoring licensed activities are properly calibrated and maintained in operable condition;

(d) Review all proposed uses of radioactive materials

and Standard Operating Procedures (SOPs) for operations involving radioactive materials prior to their review by the RSC;

(e) Administer and conduct training and educational programs for radiation safety and the usage of radiation sources;

(f) Ensure that radiological surveys, leak testing of sealed sources and checks of safety equipment are performed;

(g) Approve all procurement requests for radio-active materials prior to their purchase, all transfers (in/out bound), disposals and shipments of radioactive materials and waste;

(h) Investigate all radiological incidents and accidents and other deviations from approved radiation safety procedures and implement corrective actions as necessary;

(i) Review on a quarterly basis all occupational radiation exposure data of personnel, promptly perform an investigation when the established exposure investigational levels are exceeded to determine the cause, and if required, initiate corrective action to prevent recurrence;

(j) Brief management once each year on the radiation safety program; and

(k) Maintain a copy of the NRC license and associated documents, each licensing request and amendment, the written policy and procedures (Radiation Safety Manual), all records and reports required by NRC regulations, and Title 10, Code of Federal Regulations.

D. Authorized Users for Nonmedical Use.

1. Authorized Users and Co-Authorized Users are designated individuals who have been specifically approved by the Radiation Safety Committee (by the issuance of a Radiation Authorization) to procure, use and transfer radioactive materials and equipment that produces ionizing radiation in accordance with the conditions in their Radiation Authorization and CRD-LV's Radiation Safety Manual.

2. Authorized Users and Co-Authorized Users shall:

(a) Become thoroughly familiar with the subject matter and procedures in CRD-LV's Radiation Safety Manual and applicable NRC regulations before using radioactive materials and equipment that produces ionizing radiation;

(b) Obtain and use radiation sources only as authorized by CRD-LV's Radiation Safety Manual;

(c) Take adequate precautionary measures to protect all personnel and the public from unwarranted exposure to radiation or radioactive materials;

(d) Seek advice and assistance from the RSO when in doubt concerning the safety of an operation;

(e) Prescribe rules, procedures, SOPs, or protocols for the use of radioactive materials under his control to ensure proper and safe use. These will be made available to any radiation worker in that area and provided to the RSO when requested;

(f) Ensure that all personnel working with sources of radiation under his Radiation Authorization or in his area of responsibility receive radiation safety training as required and are knowledgeable in the specific practices and procedures to be followed or avoided in the interest of radiological safety;

(g) Ensure that all rules, procedures, and practices of radiological safety are rigorously followed in their work areas;

(h) Seek the assistance of appropriate supervisors if assistance is required in obtaining cooperation and compliance. Although the RSO is available to provide necessary technical advice on matters of radiological safety, enforcement of the requirements in CRD-LV's Radiation Safety Manual is the responsibility of the Authorized User and his immediate supervisor. All disputes should be resolved at the lowest possible level;

(i) Promptly report to the RSO any condition which may lead to or cause a violation of NRC rules and regulations, CRD-LV's Radiation Safety Manual, radiation safety procedures or unnecessary exposure to radiation or radioactive materials, including known or suspected overexposures to radiation, radioactive spills, missing or lost sources, radiological emergencies, etc;

(j) Maintain an accurate and current inventory of the quantity of radioactive material on hand (including waste) to be readily available to the RSO upon request;

(k) Ensure that radiation monitoring surveys are performed as required and contamination is controlled; and

(l) Be directly responsible to the RSC for radiation safety violations by personnel working under his/her Radiation Authorization. The RSO will report all cases of this nature to the RSC whenever appropriate corrective actions are not initiated by the Authorized User or when violations are repeated/flagrant.

Item 8. Training for individuals working in or frequenting restricted areas.

A. All individuals who in the course of employment are likely to receive in a year an occupational dose in excess of 100 mrem (1 mSv) shall be instructed as required by 10 CFR 19.12. The extent of these instructions shall be commensurate with potential radiological health protection problems present in the work place.

B. Female radiation workers will receive a copy of and be instructed to read USNRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" with Appendices A and B, be informed of their rights about declaring a pregnancy, and be instructed to contact the RSO when a pregnancy is declared.

C. Radiation workers will receive training in the safe use and handling of radioactive materials and such specialized instruction as required by the Authorized User under whose Radiation Authorization they work. Workers will adhere to the minimum rules of laboratory safety (see Item 10, paragraph B1).

D. All radiation workers will receive annual radiation safety training to be performed by the RSO or other training sources approved by the RSC.

E. Training records will be maintained.

Item 9. Facilities and equipment.

Facilities.

A. Please refer to Enclosures 6-17 for EPA facilities; these diagrams are not drawn to scale. Referencing the numbers specified in each room; the top number is the room number, the middle is a facilities identification code, and the bottom (in parenthesis) is the area of the room (sq. ft.).

B. Each usage and storage area for radioactive materials and other sources of ionizing radiation is approved by the Radiation Safety Committee. Prior to the release of a radiation usage or storage area for unrestricted use, a radiation survey is performed to ensure acceptable levels of contamination are present and a report is maintained in file.

1. Excluding the La Plaza office complex (building C) and parking area that is located at 4420 South Maryland Parkway and the EPA warehouse that is located at 3201 Sunrise Avenue #103, all other buildings are located at 944 East Harmon Avenue on the University of Nevada - Las Vegas campus. All packages of radioactive materials are delivered to the mail room (CHL 23)

whereas the larger items such as liquid scintillation counters which may contain radiation sources are initially delivered to the EPA warehouse.

2. Current areas, which are subject to change, are as follows. Annotated in parentheses after certain rooms are the maximum levels of radioactivities normally encountered in the room.

Chemistry (CHL) Laboratory
- 12 Isotope storage room (µCi)
- 14 Counting lab (environmental/exempted sealed sources)
- 15 Counting lab (environmental/exempted sealed sources)
- 16 Gas Chromatograph (GC) usage
- 23 Mail room and Sample/Standards packaging area
- 35 Radioisotope Methods Development lab (pCi)
- 36 Tritium Enrichment lab (pCi)
- 41 Radioisotopes Standards lab (low µCi)
- 42 Wet Chemistry lab (low µCi);
- 43 Tritium lab (nCi)
- 44 Performance Evaluation Studies lab (nCi)
- 61 Counting lab (environmental/exempted sealed sources)
- 62 Counting lab (environmental/exempted sealed sources)
- 63 Counting lab (environmental/exempted sealed sources)
- 66.1 RSO's office (no material)

Executive Center Vault (basement)
- 5 Whole Body counter (exempted sealed sources) and Dosimetry Center (Cs-137 sealed source, NRC License Item 6-9 DD)

Monitoring Sciences Laboratory (MSL)
- 18 Calibration facility (numerous exempted sealed sources and NRC License Items 6-9 V-Z, CC, and EE)

Quality Analysis Laboratory (QAL)
- 4 Tracer laboratory (µCi of H-3/C-14)
- 18 Storage for portable x-ray analyzers
- 19 Counting and GC usage room
- 45 Storage refrigerator (µCi of H-3/C-14)
- 46 Storage for portable GC and x-ray analyzers

Environmental Annex (EAX) Building
- Radon Laboratory/Chambers (low µCi)

Modular Office Complex (MOD), 300 yards north of MSL building
- 11 Office-Storage of exempt quantity sealed sources

La Plaza Office Complex - 1st Floor, Building C
- 519 Electronics Shop (exempt quantity sealed sources)
- 521 GC usage

EPA Government Parking Compound at La Plaza
Locked emergency response (Mobile Laboratory and Sample Preparation Trailer) and other vehicles containing exempt quantity calibration standards.

C. The majority of all dispersible radioactive materials at this facility are used/stored in CHL rooms 12, 41, 42, and 44 (Type C laboratories). Primary solutions, standards, samples, and other materials (RSO's waste) are stored in room 12. Primary solutions are diluted and ampulated, standards are prepared, and radiochemistry purification procedures are performed in room 41. Environmental radiochemistry procedures are performed in room 42. Performance Evaluation samples are prepared and archival samples are stored in room 44. Radioactive liquid waste disposals are currently authorized in rooms 41 and 44. Rooms are at negative pressure whenever the fume hoods are operating.

D. MSL 18, Instrument Calibration Facility.

1. Only those individuals who are required to work with the radiation sources in this area are authorized access (with positive control for each individual entry) to this controlled, restricted, High Radiation Area. When using the calibration well sources, individuals are required to wear their whole body personnel monitoring device in addition to a calibrated pocket dosimeter.

2. Access to the rooftop of MSL is controlled from outside the building by the use of a secured (by lock) grate to the access ladder and from inside the calibration facility by a lock to each of the two rooftop opening steel panel doors.

3. A protective barrier, five feet in height and posted with radiation warning signs, is constructed on the rooftop immediately over the two calibration wells to limit access. The barrier has four red warning lights, posted at the top of each corner, and two bells (continuously ringing) that are activated when the calibration well sources are in use.

4. When the sources are in use, red warning lights inside and outside the room, and above the entrance door, are activated.

5. Access to the calibration sources is limited to only those radiation workers who have been trained in the use of these sources and by a key to the calibration well lead shielded cover and a key to the control system for activating the sources from and to their storage positions.

6. In the room is an area exposure rate monitor set at 5 millirem per hour to alert workers of potential hazards.

E. Temporary job sites for the usage of portable instruments containing radioactive material and other sources of ionizing radiation for analyses, calibration, and training purposes.

1. All radiation sources used in the field will be secured, controlled, transferred, and transported in accordance with applicable NRC and Department of Transportation regulations. Normally, exempt-quantity sealed sources are used for calibrating equipment and training purposes whereas the portable GCs, x-ray analyzers, and calibrators have specific usages.

2. Tracer studies involving the direct release of radioactive material into the environment are not performed, nor authorized.

3. Some personnel are actively involved with the Federal Radiological Monitoring and Assessment Center (FRMAC) and EPA Office of Radiation and Indoor Air's Radiological Emergency Response Team. Personnel also provide radiological support to Superfund sites, various States and participate in radiological and emergency training exercises.

Equipment used for NRC licensed activities.

A. Surveying/monitoring equipment. There will be made available to personnel an operable and calibrated radiation survey and monitoring instrument capable of detecting or measuring the appropriate energy of the ionizing radiation (alpha, beta or gamma) in usage/storage areas. An example of instruments currently in the inventory include the Eberline Geiger Counter Model E-140 (range from 0 to 50,000 cpm), Eberline Model RO-2A (ion chamber with range from 0 mR/hr to 5 R/hr), Ludlum Model 19 Micro-R Meter (scintillation probe with range from 0 to 5000 µR/hr), and an Eberline Portable Alpha Counter, Scintillation type, Model PAC-1SA (range from 0 to 2.0 E6 cpm).

B. Counting equipment. Numerous counters for the measurement of various radionuclides and their alpha, beta, and/or gamma emitters are available for use. Examples of available counting equipment are various liquid scintillation counters (Beckman LS 9800 and the Packard Tri-Carb 2560 TR/XL), Nuclear Data Inc. systems (gamma spectroscopy), NUMELEC NU20 Multidetector (alpha-beta), Tennelec Gas Proportional counting system and a Canberra whole body counter.

C. Calibration of instruments used for licensed activities. Calibrations will be performed by the use of a calibrated radioactive standard that is traceable to National Institute of Standards and Technology (NIST). Calibration procedures will be in accordance with the manufacturer's specifications or procedures approved by the RSO. Documented records for

calibrations and other tests will be maintained and available for review.

1. Portable radiation survey instruments.

(a) Specific calibration procedures vary among instruments because of the characteristics of the instruments, however the following requirements are common for all calibrations:

(1) Calibrations are performed at least annually and by the use of a calibrated source having ±5 percent accuracy;

(2) Each scale will be calibrated at two points (at least), which are located approximately at 20 percent and 80 percent of full scale, depending upon the full scale;

(3) For logarithmic rate-changing instruments, the calibration will be made near the mid-range of each decade and two points will be calibrated on at least one of the decades; and

(4) The measured exposure rate will differ from the true exposure rate by less than or equal to ± 10 percent at the calibration points. Readings greater than ± 10 percent but less than ± 20 percent are acceptable provided that a calibration chart, graph, or response factor is prepared and used with the instrument to interpret readings to within ± 10 percent for radiation protection purposes.

(b) An instrument database will be maintained, specifying the calibration date, calibration due date, status and location of each instrument.

(c) Each calibrated instrument will have an affixed label indicating the calibration date, calibration due date and initials of the individual who performed the calibration.

(d) Instruments that are not operable or out of calibration will be appropriately tagged and not used.

2. Instruments/counters that evaluate contamination, wipe test, and bioassay results. Quality Control checks will be performed on the equipment prior to its usage. The tests (if applicable) specified below will be performed at least annually and after a new detector has been installed.

(a) Chi-square (reproducibility) test;

(b) Counting efficiencies;

(c) High voltage (plateau) determination; and

(d) Minimum detectable activity (MDA).

Item 10. Radiation Safety Program.

A. Authorization to use radioactive materials. Before an individual can procure, receive or use radioactive materials or equipment that produces ionizing radiation, he must first obtain written approval (a Radiation Authorization) from the RSC to become an Authorized User.

1. New Radiation Authorization.

a. Individuals are to contact the RSO for procedural and administrative guidance and will:

(1) Be provided a copy of CRD-LV's Radiation Safety Manual and schedule with the RSO a radiation safety training class for all individuals who will be using the radiation sources;

(2) Prepare one copy of the "Request for Authorization to Use Radioactive Material" form, specifying "New," and complete the requested information in all sections on the front, including the required signatures (excluding the RSC's approval section), and back side of the form (Enclosure 18);

(3) Ensure that all workers document their radiation safety training and usage experience on the "Training and Experience of Radiation Worker" form (Enclosure 19);

(4) Write Standard Operating Procedures (SOPs) for all proposed usages of the requested radioactive materials, i.e., protocols, research projects, etc. Radiation exposure calculations and literature reports, when applicable, are to accompany protocols; and

(5) Submit all forms, records, documents and SOPs to the RSO, who will review the request for authorization to use radioactive materials prior to its submission to the RSC. The RSO will verify the presence and accuracy of the required information on all documents and ensure the requested procedures, radionuclides and their activities, etc., are in accordance with the Radiation Safety Manual and authorized by the NRC license. If additional operating conditions or restraints are required to ensure personnel safety or compliance with regulatory procedures, the RSO will discuss these with the individual, who will incorporate these conditions into his request.

b. The RSO will perform a formal radiation protection survey by completing the "Radiation Safety Evaluation for Use of Radioactive Material" form (Enclosure 20) of the proposed use

and/or storage areas to evaluate personnel, equipment, and safety requirements.

c. The individual's request with accompanying information and the RSO's radiation protection survey report will be presented to the RSC for review, discussion, approval or disapproval. The RSC will evaluate the request for compliance with regulatory and radiological safety requirements to ensure that exposures to workers and the public are maintained ALARA. If the RSC recommends additional restraints or conditions, the individual will incorporate these into his request.

d. Following approval by the RSC, the Radiation Authorization will be signed by the Chairperson and maintained in file by the RSO and User.

2. Amendment of Radiation Authorization.

a. Prior to deviating from procedures, requirements or changing usage or storage areas, radionuclides and their limits as specified in his approved Radiation Authorization, the Authorized User will first obtain approval for the proposed changes from the RSC by the issuance of an amendment to his radiation authorization.

b. The Authorized User will prepare and complete one copy of the "Request For Authorization to Use Radioactive Material" form, specifying "Amendment", annotate the proposed change(s) in the appropriate section(s) and provide all associated documents, SOPs, records as required to the RSO.

c. The aforementioned procedures (for obtaining an authorization) are repeated.

3. Review of Radiation Authorization.

a. Current Radiation Authorizations require biennial review by the RSC and at other times as requested by the RSO. Authorized Users will prepare and complete one copy of the "Request for Authorization to Use Radioactive Material" form, specifying "Review", with information current as to his last approved amendment. All documents, records, SOPs, etc., from his initial request and any subsequent amendments will accompany the authorization request forms and be provided to the RSO.

b. The aforementioned procedures (for obtaining an authorization) are repeated.

B. Radiation control measures.

1. Minimum rules of laboratory safety for radiation workers are as follows.

a. All radiation workers are adequately trained in the hazards, safety precautions, and proper use of radioactive materials or equipment which produces ionizing radiation.

b. Do not eat, chew, drink, use tobacco products (smoke, snuff, chewing tobacco), or apply cosmetics in any area where radioactive materials are stored or in use. Food and drink are not permitted in any area or room, including refrigerators, where radioactive materials are stored or in use.

c. Do not use laboratory glassware or equipment for the preparation or consumption of food or drink. Eliminate all sharp objects, broken glassware, etc., from usage areas and keep areas free from unnecessary materials and equipment.

d. Wear appropriate disposable gloves to prevent hand contamination when handling radioactive materials. Additional protective attire such as lab coats or aprons, face shields or caps may be warranted, depending on the level of activity, hazard of the radionuclide, and the type of work planned. Do not handle the telephone, cabinet or drawer handles, door knobs and non-radio-active items with contaminated hands or gloves.

e. Wear your dosimeter (if issued) as required and store it in the approved location when work is completed.

f. Never pipette solutions by mouth.

g. Control and secure all radioactive materials as required, including items, equipment, etc., that are labeled as radioactive.

h. Be aware of external and container surface exposure rates and use remote handling devices when appropriate.

i. Visually inspect the source container for damage or leakage prior to use. Use secondary spill containment whenever possible, i.e., work in a tray with absorbent paper to limit the spread of contamination. Store the source in a secondary container in case of leakage and transport the source in an unbreakable container (plastic bag) in case of droppage.

j. Use shielding whenever possible and if appropriate. Pipette from shielded containers and place the containers behind or into shields when not in use. Transport sources in shielded containers.

k. Be aware of the chemical properties of the radionuclide you are working with to avoid uncontrolled releases of activity. Tritium, radioiodines, polonium, ruthenium, plutonium and many others form chemically mobile (volatile) compounds. Others such as Ra-226 give rise to volatile daughter

products. Volatile materials will be vented and used in a fume hood.

l. Label all containers (vials, test tubes, flasks, beakers, etc.) of radioactive materials as required. Mark all radiologically contaminated or potentially contaminated containers and equipment clearly with radioactive marking tape.

m. Segregate all radioactive waste from non-radioactive waste. Segregate liquid from solid radioactive waste. Segregate mixed radioactive waste containing hazardous materials from radioactive waste. Dispose of radioactive waste in appropriately labeled receptacles. Obtain approval from the RSO prior to the disposal of any radioactive waste and maintain records for all disposals.

n. Prior to the removal or disposal of empty uncontaminated containers or items to unrestricted areas (normal trash), remove, deface the radioactive label, radiation symbol and/or the words "radioactive materials" or otherwise indicate that the item no longer contains radioactive materials.

o. After the completion of work, change absorbent paper, decontaminate areas, clean up equipment, etc., to avoid any build up of contamination. Wash hands with mild soap and water immediately following work completion. Monitor hands, clothing and work areas for contamination with an appropriate, calibrated survey instrument. Lab coats worn while using radioactive material should not be worn in non-usage areas as contamination on the coat may be spread, absorbed, or ingested if care is not taken.

p. Report all known or suspected exposures, spills, inhalations, contamination, ingestions, absorptions, injections, injuries and missing or lost radiation sources <u>immediately</u> to the RSO and your supervisor. If a wound, cut, etc., occurs while handling radioactive materials, immediately wash or flush the injured area with running water.

q. Reduce exposure to radiation by:

(1) Time - work efficiently and expediently;

(2) Distance - Use handling tools (tongs, forceps);

(3) Shielding - Keep the vial in the container provided and place radioactive materials behind shielding. Use plastic, not lead, to shield beta emitters; and

(4) Practice contamination control procedures.

2. Storage and control of radioactive material.

a. Security of stored material. Personnel will secure from unauthorized removal or access radioactive materials that are stored in controlled or unrestricted areas.

b. Control of material not in storage. Personnel will control and maintain constant surveillance of radioactive material that is in a controlled or unrestricted area and that is not in storage.

c. Any radioactive material that is found, lost, stolen or missing will be immediately reported to the RSO, who will notify the NRC if required by 10 CFR 20.2201.

3. Posting requirements.

a. Areas, accessible to individuals, where radioactive materials are used, handled or stored are controlled, restricted areas and shall be posted to warn personnel of the presence of radiation and radioactive materials and the associated potential hazard(s). Areas are appropriately posted with a caution sign(s) having the radiation symbol as:

(1) "Caution - Radioactive Materials" when the amount of radioactive material in the room or area that is in use or in storage exceeds 10 times the quantity of such material specified in Appendix C to 10 CFR 20;

(2) "Caution - Radiation Area" when radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) or equal to, but not more than, 0.100 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates;

(3) "Caution (or Danger) - High Radiation Area" when radiation levels could result in an individual receiving a dose equivalent in excess of 0.100 rem (1 mSv) in 1 hour at 30 centimeters or equal to, but not more than, an absorbed dose of 500 rads (5 grays) in 1 hour at 1 meter from the radiation source or from any surface that the radiation penetrates;

(4) "Grave Danger, Very High Radiation Area" when radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from the radiation source or from any surface that the radiation penetrates;

(5) "Caution (or Danger) - Airborne Radioactivity Area" when radioactive material concentrations exceed 10% of any derived air concentration (DAC) value specified in Appendix B to 10 CFR 20;

(6) "Contaminated Area" when excessive radioactive contamination levels warrant decontamination;

(7) "Caution - Radioactive Waste" for receptacles for the accumulation or storage of radioactive waste;

(8) "Caution - Radioactive Material Disposal Sink" for specifically designated sinks, approved by the RSO, through which soluble radioactive material is discharged into the sanitary sewerage system for disposal; and

(9) Additional information, as appropriate, may be provided on or near the required sign to alert individuals of potential radiation exposures and to minimize radiation exposure.

b. Posting is not required for:

(1) Rooms or areas containing radioactive materials for periods of less than 8 hours provided that:

(a) The materials are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure to individuals to radiation or radioactive material in excess of the limits specified in 10 CFR 20; and

(b) The room or area is subject to the Authorized User's control; and

(2) Rooms or areas because of the presence of a sealed source provided that the radiation level at 30 centimeters from the surface of the source container or housing does not exceed 0.005 rem (0.05 mSv) per hour.

4. Labeling of containers.

a. Each container shall bear a durable, clearly visible label bearing the radiation symbol and the words "Caution (or Danger), Radioactive Material." The label must provide sufficient information (such as the radionuclide(s) present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrich-ment) to permit individuals handling or using the containers or working in the vicinity of the containers to take precautions to avoid or minimize exposures. Additional information may be provided on or near the required label to alert individuals of potential radiation exposures and to minimize radiation exposure.

b. Prior to the removal or disposal of empty uncontaminated containers or items to unrestricted areas, the

radioactive material label, radiation symbol and/or the words "radioactive materials" will be removed, defaced or otherwise indicated that the container or item no longer contains radioactive materials.

c. Labels are not required for containers:

(1) Holding radioactive material in quantities less than the quantities listed in Appendix C to 10 CFR 20;

(2) Holding radioactive material in concentrations less than those concentrations specified in Table 3 of Appendix B to 10 CFR 20;

(3) Attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established in 10 CFR 20;

(4) Having excepted quantity or an article of radioactive material as defined and limited by the Department of Transportation (DOT) regulations (Title 49, CFR 173.403(m), (w) and 173.421-424), when the container is in transport and packaged and labeled in accordance with DOT regulations;

(5) That are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record, which must be retained as long as the container is in use for the purpose indicated on the record; and

(6) Installed manufacturing or process equipment.

5. Access to areas.

a. Access to areas or rooms that are posted with the precautionary radiation warning sign(s) is controlled and restricted to protect individuals from exposure to radiation and radioactive materials. Personnel will maintain the security and control of radioactive materials and radiation in these areas.

b. Access to the Calibration Facility in MSL-18, which is a High Radiation Area. See Item 9, Facilities and Equipment, paragraph D.

6. Radiation surveys.

a. Radiation monitoring surveys are performed to evaluate known or potential radiological hazards in restricted and unrestricted areas to ensure that radiation exposures to workers and the public are maintained at levels that are ALARA. These surveys may include the following determinations depending

upon the specific needs of the monitoring: radiation levels, surface contamination levels, effluent releases, radioactive waste management, radiation safety and contamination control procedures.

b. The RSO will:

(1) Prior to the usage or storage of radioactive materials in an area or room, perform a formal radiation protection survey to evaluate personnel, equipment and safety requirements; and

(2) Perform or ensure the performance of all required surveys for the evaluation of the extent of radiation levels, concentrations or quantities of radioactive material and the potential radiological hazards that could be present.

c. Authorized Users will ensure the performance of:

(1) Daily radiation instrument monitoring surveys for radiation levels in rooms when dispersible forms of radioactive materials equal to or greater than those quantities specified in Schedule B to 10 CFR 30.71 are used;

(2) Quarterly wipe tests for surface contamination in areas, including adjacent unrestricted areas, where dispersible forms of radioactive materials are used or stored. A radiation instrument monitoring survey for accessing radiation levels will be performed in conjunction with the wipe test;

(3) Contamination and/or radiation monitoring surveys on equipment or items used with radioactive materials prior to their removal from the room to an unrestricted area. The RSO will verify the results of these surveys before approving the removal of the item from the room; and

(4) Radiation monitoring surveys in areas or rooms, including adjacent unrestricted areas, where sealed sources are used or stored.

d. The radiation monitoring and contamination survey records will have, at a minimum, the location, identification of the radiation monitoring or counting instrument used, name or initials of person conducting the survey, the date the survey was performed, a drawing of the area surveyed with specific points that were surveyed, the measured exposure rates, detected contamination levels, and corrective action taken in the event of excessive contamination or exposure rates.

e. Radiation surveys will be performed with, and their results analyzed by, calibrated equipment. Documented

records will be maintained and provided to the RSO when requested.

7. Contamination control and decontamination procedures.

a. Responsibilities.

(1) The RSO will control radioactive contamination and supervise decontamination procedures.

(2) Each Authorized User will:

(a) Control contamination within his work area and provide the resources for decontamination; and

(b) Promptly report all spills, releases, accidents, incidents, or unusual occurrences so that contamination control procedures may be initiated.

(3) If possible, the individual responsible for the contamination will perform the decontamination.

b. Contamination control.

(1) Methods which should be employed to minimize the spread of radioactive contamination include:

(a) Using personal protective clothing and devices such as rubber or plastic gloves, laboratory coats, shoe covers, head covers, face masks, respirators, etc.;

(b) Using radiation survey instruments capable of monitoring contamination for the particular radionuclide(s) in use;

(c) Using separate, specially marked radioactive waste containers;

(d) Using polyethylene bags to contain waste and to line waste containers;

(e) Limiting traffic and occupancy of work areas where radioactive materials are in use or in storage;

(f) Designing/enforcing work flow and procedures to minimize transfers and manipulations of radioactive material;

(g) Conducting procedures which generate radioactive aerosols, dusts, or gaseous products in fume hoods, glove boxes, or other suitable closed systems;

(h) Designating and posting contaminated and potentially contaminated areas during procedures which are likely to produce contamination;

(i) Covering working surfaces with polyethylene and absorbent disposable material;

(j) Using trays capable of containing a total spill of the liquid radioactive material being used;

(k) Using double containers for vessels of radioactive materials which are easily upset (volumetric flasks);

(l) Avoiding the use of laboratory vacuum systems and lines when using radioactive materials;

(m) Posting cabinets, refrigerators, ovens, etc., where radioactive material is used or stored so that all personnel are advised of its presence. When the item is not used exclusively for radioactive material, the radioactive material should be separated from the other contents and conspicuously posted;

(n) Establishing control points outside contaminated areas where personnel will monitor themselves for contamination with a suitable radiation survey instrument before leaving the area; and

(o) Promptly cleaning up, monitoring and notifying the RSO of all spills of radioactive material.

(2) Contamination in excess of the levels in the following two tables warrant action (decontamination).

Acceptable Levels for Removable Surface Contamination*

	Type of Radiation Emitter					
	Alpha		Beta-gamma		Low-risk Beta-gamma	
Type of surface	(μCi/cm^2)	(dpm/100 cm^2)	(μCi/cm^2)	(dpm/100 cm^2)	(μCi/cm^2)	(dpm/100 cm^2)
Unrestricted Areas, including personal clothing worn outside restricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
Restricted areas, including personal clothing worn only in restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,200
Skin	10^{-6}	220	10^{-6}	220	10^{-5}	2,200

Acceptable Surface Contamination Levels for the Uncontrolled Release of Equipment*

Radionuclide	Removable (dpm/100 cm^2)	Total (Fixed + Removable) (dpm/100 cm^2)
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-228, Th-230, Pa-231, Ac-227, I-125, I-129	20	100
Sr-90, I-126, I-131, I-133, Th-natural, Th-232, U-232, Ra-223, Ra-224	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission), except Sr-90 and others specified above	1,000	5,000
Tritium organic compounds, HT, HTO, and metal tritide aerosols	10,000	10,000

* Notes for the above two tables.

1. When surface contamination by both alpha and beta-gamma emitting radionuclides exists, the limits specified for each emitter type should apply independently.

2. These limits apply to contamination deposited on, but not incorporated into the interior of the contaminated item.

3. Beta-gamma emitter values are applicable for all beta-gamma emitters other than those considered low-risk.

4. Low-risk beta-gamma emitters include C-14, H-3, S-35 and others whose beta energies are less than 0.2 MeV maximum and gamma emission is less than 0.1 R/hr at 1 meter per curie.

5. The amount of removable radioactive material per 100 cm^2 of surface area, or 300 cm^2 for larger surfaces, should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive materials on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface area should be swiped and the activity per unit area should be based on the actual surface area. Measurements of average contaminant should not be averaged over more than 1 square meter.

6. Except for transuranics, Ra-226, Ra-228, Ac-227, Th-228, Th-230, Pa-231 and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.
**********END OF NOTE SECTION FOR TABLES**********

c. Decontamination procedures.

(1) General. Decontamination methods are many and varied.

(a) A decontamination kit with all required supplies should be immediately available to expedite decontamination procedures and therefore reduce potential exposure to radiation and radioactive materials.

(b) Cleaning agents normally used in the laboratory should be adequate, however Radiac or Decon wash should be used to expedite decontamination efforts.

(c) An appropriate, calibrated radiation survey instrument or wipe tests should be used to monitor the effectiveness of the decontamination procedure.

(d) Continued decontamination efforts should be employed until acceptable levels have been obtained or otherwise approved by the RSO.

(e) Some degree of fixed contamination may occur. The RSO will provide further, specific guidance and approve the release of contaminated personnel and items to unrestricted areas.

(f) Contaminated cleaning equipment, items, articles, etc., will be collected as radioactive waste and disposed as directed by the RSO.

(2) Decontamination of individuals.

(a) Remove contaminated clothing at the earliest opportunity; collect, store and dispose of clothing as directed by the RSO.

(b) Promptly perform decontamination of the skin and hands by applying water, a mild soap or detergent (no solvents), and working up a good lather with plenty of water. Rinse and dry thoroughly. Monitor for effectiveness.

(c) If contamination is still excessive, repeat the procedure 3 to 4 times, using a soft bristle brush and taking care not to abrade or scratch the skin. Clipping of the

fingernails or cuticles may remove a significant amount of contamination remaining on the hands after washing. Monitor for effectiveness.

(d) If contamination is still excessive, use a more abrasive soap, taking care to prevent the absorption of the contamination through the skin. If excessive contamination still exists, the RSO will provide specific guidance for preventing cross-contamination.

(e) Apply lanolin/cream to prevent chapping.

(f) Wounds suspected of contamination should be irrigated profusely with warm water and cleaned with a swab; procedures should be performed under the supervision of medical personnel.

(3) Decontamination of surface areas, equipment.

(a) Personnel will wear protective gloves and, as required, clothing, shoe covers, etc. to prevent cross-contamination.

(b) Start decontamination procedures as soon as possible.

(c) Start at the periphery of the contaminated area and work inward, reducing the contaminated area systematically.

(d) Monitor for effectiveness and continue decontamination procedures until acceptable contamination levels have been obtained or otherwise determined by the RSO.

(e) Collect all contaminated materials used as radioactive waste and dispose as directed by the RSO.

8. Respiratory protection. Due to the limited quantities of radioactive materials used and handled by workers and the radiation control and safety measures employed to prevent the intake of radioactive materials, the use of respiratory protection equipment by personnel is not required. When required, respiratory protection equipment and procedures will be in accordance with 10 CFR 20.1703.

C. Radiation dose limits.

1. Occupational dose limits for adults. Occupational dose shall be controlled, except for planned special exposures under 10 CFR 20.1206, for the following dose limits.

a. An annual limit, which is the more limiting of:

(1) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(2) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

b. The annual limits to the lens of the eye, to the skin, and to the extremities, which are:

(1) An eye dose equivalent of 15 rems (0.15 Sv) and

(2) A shallow-dose equivalent of 50 rems (0.5 Sv) to the skin or to any extremity.

c. In addition to the annual dose limits, the soluble uranium intake by an individual shall be limited to 10 milligrams in a week in consideration of chemical toxicity (refer to footnote 3 to Appendix B to 10 CFR 20).

2. Occupational dose limits for minors. The annual occupational dose limits for minors are 10 percent of the annual dose limits for adult workers.

3. Dose to the embryo/fetus.

a. Due to the occupational exposure of a declared pregnant worker, the dose to the embryo/fetus during the entire pregnancy shall not exceed 0.500 rem (5 mSv).

b. The dose to the embryo/fetus shall be the sum of:

(1) The deep-dose equivalent to the declared pregnant worker; and

(2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant worker.

c. If the dose to the embryo/fetus is found to have exceeded 0.500 rem (5 mSv) or is within 0.050 rem (0.5 mSv) of this dose by the time the worker declares the pregnancy, the additional dose to the embryo/fetus shall not exceed 0.050 rem (0.5 mSv) for the remainder of the pregnancy.

4. Individual members of the public.

a. For the protection of individual members of the public, licensed activities and operations shall be conducted to ensure that:

(1) The total effective dose equivalent does not

exceed 0.100 rem (1 mSv) in a year, exclusive of the dose contribution from the disposal of radioactive material into sanitary sewerage in accordance with 10 CFR 20.2003; and

(2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour.

b. These dose limits also apply if members of the public (visitors) are permitted access to controlled areas by workers.

Summary Table for Dose Limits

Type of Exposure	Annual Limit
Radiation worker:	
Whole Body (internal + external)	5 rem
Lens of the eye	15 rem
Extremity (hands and arms below the elbow; feet and legs below the knees)	50 rem
Any organ or tissue (other than the lens of the eye) and skin	50 rem
Minors: 10% of the above limits	
Embryo/fetus of Declared Pregnant Worker (internal + external)	0.5 rem in 9 months
Visitors, public and minors:	
Whole Body (internal + external)	0.1 rem

D. Personnel monitoring.

1. General.

a. Personnel monitoring is used to quantitatively estimate the magnitude of individual exposures to sources of ionizing radiation and detect hazardous conditions relating to ionizing radiation exposure not detected during radiation protection surveys.

b. The dose that an individual may be allowed to receive in the current year will be reduced by the amount of occupational dose received while employed by a non-EPA facility.

c. When required, the summation of external and internal doses will be in accordance with 10 CFR 20.1202.

d. Doses received in excess of the annual limits, including doses received during accidents, emergencies and planned special exposures, will be subtracted from the limits for planned special exposures that the individual may receive during the current year and the individual's lifetime.

e. When required, planned special exposures for personnel will be conducted, performed, recorded and reported as required by 10 CFR 20.1206, 20.2104(b), 20.2105 and 20.2204.

2. Requirements for external monitoring. Monitoring the occupational exposure to radiation from sources external to the body and the employment and use of individual monitoring devices is required for:

a. Adults likely to receive, in 1 year, a dose in excess of 10 percent of the limits specified in paragraphs C1a and b;

b. Minors and declared pregnant workers likely to receive, in 1 year, a dose in excess of 10 percent of the limits specified in paragraphs C2 and 3;

c. Individuals entering a high radiation area; and

d. Individuals selected by the Director or RSO.

3. Requirements for internal monitoring.

a. General. Radioactive xenon is not used and only submicrocurie amounts of I-125 are infrequently used (4 µCi was received in 1995). The maximum amount of liquid I-131 received and handled by a limited number of workers is 130 microcuries; this occurs once each calendar quarter. Radioactive iodine is initially vented in the fume hood prior to its usage. EPA radiation workers who participated in the Human Offsite (of Nevada Test Site) Surveillance Program have been, until recently, whole body counted and have had infrequent urine analyses for tritium (and other radionuclides); the results indicate that workers have not received any internal exposure to radiation or radioactive materials. Bioassays on workers are not currently being performed. When warranted, bioassays will be performed in accordance with USNRC Regulatory Guide 8.20.

b. Monitoring the occupational intake of radioactive materials and the assessment of the committed effective dose equivalent is required for:

(1) Adults likely to receive, in 1 year, an

intake in excess of 10 percent of the applicable annual limit on intake(s), or ALI(s), in Table 1, Columns 1 and 2, of Appendix B to 10 CFR 20; and

(2) Minors and declared pregnant workers likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.050 rem (0.5 mSv).

4. Personnel Dosimetry Accreditation. All personnel dosimeters, excluding direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities, that require processing to determine the radiation dose shall be processed and evaluated by a processor holding a current personnel dosimetry accreditation and approved in this accreditation process for the type of radiation or radiations that closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

5. Devices and Methods for Personnel Monitoring.

a. External Monitoring.

(1) The primary device for external personnel monitoring is the thermoluminescent dosimeter (TLD), which is sensitive to various types of radiations. The whole body TLD is used by personnel to measure the exposure received to the whole body. Other dosimetry devices approved by the RSO may be used to supplement the whole body TLD.

(2) When determining the external dose from airborne radioactive material, the contribution to the deep-dose equivalent, eye dose equivalent and shallow-dose equivalent from the external exposure to the radioactive cloud will be included.

(3) The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure. The deep-dose equivalent, eye dose equivalent and shallow-dose equivalent may be assessed from surveys or other radiation measurements if the individual monitoring device was not in the region of highest potential exposure or the results of individual monitoring are unavailable.

b. Internal Monitoring.

(1) For purposes of determining internal exposure, suitable and timely measurements will be taken of:

(a) Concentrations of radioactive materials in air in work areas;

(b) Quantities of radionuclides in the body;

(c) Quantities of radionuclides excreted from the body; or

(d) Combinations of these measurements.

(2) Derived air concentration (DAC) and annual limit on intake (ALI) values in Table 1 of Appendix B to 10 CFR 20.1001 - 20.2401 may be used to determine an individual's dose.

(3) Note: Demonstrating compliance with 40 CFR 61 Subpart I regarding radionuclide emissions to the atmosphere, specifically not having to file a report with EPA, negates the requirements for the aforementioned paragraphs D5b(1) and (2).

6. Administration.

a. After receiving radiation safety training from the RSO, the individual will complete an application for a dosimeter and provide previous employment radiation exposure information.

b. Upon issuing the individual a dosimeter, the External Dosimetry Manager will initiate a dosimetry file for the individual and request/obtain previous radiation exposure records which will be included into the individual's dosimetry record and maintained in file.

c. Dosimeters will be worn on a quarterly basis, exchanged by the External Dosimetry Manager, or when deemed otherwise by the RSO.

d. Personnel will adhere to those procedures for the usage and storage of their dosimeters and will obtain approval from the RSO and a control dosimeter from the External Dosimetry Manager prior to taking their dosimeter to a place of duty not normally encountered (out-of-state, foreign country, etc.).

e. When terminating employment, transferring or leaving EPA, personnel will out-process the office of the RSO.

f. Personnel monitoring for certain individuals may be discontinued at the discretion of the RSO.

g. Prior to entering an existing High Radiation Area, individuals will obtain and wear a pocket dosimeter and annotate the required information into the logbook prior to entering and after leaving the area. The RSO will be immediately notified of any abnormal pocket dosimeter readings.

h. Each location for storing dosimeters when not being worn by individuals will be approved by the RSO. A Control dosimeter will be placed at each storage location to measure background radiation.

7. Reports and records. The Dosimetry Manager will maintain and provide reports and records as required in 10 CFR 20.

8. Notifications.

a. The Dosimetry Manager will immediately notify the RSO of those radiation exposures warranting notification or exceeding ALARA investigat ɔnal level limits.

b. The RSO will perform investigations, inform the RSC of the results, and notify the NRC of reportable exposures.

E. Procedures for the usage and storage of personnel dosimeters.

1. Dosimeters will not be used for any purpose other than personnel monitoring without the approval of the RSO. Dosimeters are used to measure the radiation dose received by personnel who are occupationally exposed to radiation as radiation workers.

2. Dosimeters will be worn only by the individual to whom they are issued and are to be worn when working with sources of radiation. Other dosimeters to be worn will be approved and worn as mandated by the RSO.

3. The whole body dosimeter is to be worn on the front, upper torso of the body between the neck and waist, with the thin plastic window on the face of the dosimeter facing away from the body.

4. When not being worn, the dosimeter will be stored only in the approved storage location. Dosimeters are not to be taken home or stored in desks, lockers, radiation usage/storage areas, on lab coats, etc.

5. Dosimeters will not be intentionally exposed, tampered with, or damaged in any way and protected from heat, thermal shock and the sun.

6. Dosimeters will not be worn during medical/dental x-ray diagnosis or therapy exposures involving radiation. Workers will notify the RSO before receiving a radioisotope treatment or procedure (the injection or administration of radioactive materials into the body). Dosimeters will not be worn during or after the procedure/treatment until approval has been obtained from the RSO.

7. The RSO will be immediately notified whenever a dosimeter is lost, missing, accidently exposed/contaminated or damaged.

8. CRD-LV's dosimeters will not be worn by workers when performing non-EPA duties at other facilities while being occupationally exposed to radiation. Personnel will provide their non-EPA exposure records to the External Dosimetry Manager for inclusion into their dosimetry record and file.

9. Workers being required to wear dosimeters at a duty location not normally encountered (out-of-state, foreign country, etc.) will obtain instructions and approval from the RSO and a Control dosimeter from the External Dosimetry Manager prior to leaving for that duty location.

F. ALARA program.

1. Purpose. To provide guidance for maintaining radiation exposures (individual and collective) at a level that is As Low As Reasonably Achievable (ALARA).

2. Scope. To prescribe the principles and practices for maintaining radiation exposures ALARA and designate responsibilities for the administration and operation of the program.

3. Definition. ALARA means "As Low As Reasonably Achievable" taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety.

4. Responsibilities.

a. The CRD-LV Director is:

(1) Committed to the program described herein for keeping radiation exposures (individual and collective) ALARA.

(2) To ensure that a formal review of the radiation safety program is conducted annually.

(3) To ensure that modifications to equipment, facilities, and operating and maintenance procedures for reducing exposure levels will be implemented unless the cost is considered unjustified.

b. Radiation Safety Committee (RSC).

(1) The RSC will thoroughly review the qualifications of each applicant with respect to the requested types and quantities of materials and their usages to ensure that the applicant will be able to take appropriate measures to maintain exposures ALARA.

(a) When considering a new use of radioactive material, the RSC will review the applicant's efforts

to maintain exposures ALARA. The applicant will have systematized procedures to ensure exposures are ALARA and will incorporate the use of special equipment in his proposed use.

(b) The RSC will ensure that the applicant justifies his procedures and that doses (individual and collective) to workers and the public will be ALARA.

(2) Delegation of Authority. The judicious delegation of RSC authority is essential to the enforcement of an effective ALARA program.

(a) The RSC will delegate authority to the RSO for enforcement of the ALARA concept.

(b) The RSC will support the RSO in those instances where it is necessary for the RSO to assert his authority. When the RSO has been overruled, the RSC will record the basis for its actions in the minutes for the RSC meeting.

(3) Review of ALARA Program.

(a) The RSC will encourage all users to review concurrent procedures and develop new procedures, as appropriate, to implement the ALARA concept.

(b) The RSC will perform a quarterly review of occupational radiation exposures with particular attention to instances when the Investigational Levels in paragraph 5a are exceeded. The principle purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when Investigational Levels are exceeded.

(c) The RSC will evaluate the laboratory's overall efforts for maintaining exposures ALARA on an annual basis. This review will include the efforts of the RSO, Authorized Users and workers as well as those of management.

c. Radiation Safety Officer (RSO).

(1) Reviews.

(a) Annual Review of the Radiation Safety Program. The RSO will perform an annual review of the Radiation Safety Program for adherence to ALARA concepts. Reviews of specific procedures may be conducted on a more frequent basis.

(b) Quarterly Review of Occupational Exposures. The RSO will review at least quarterly the external radiation exposures of radiation workers to determine that their exposures are ALARA in accordance with the provisions of this

program.

(c) Quarterly Review of Records of Radiation Levels. The RSO will review at least quarterly the records of radiation levels in unrestricted and restricted areas and (when applicable) the releases of effluents to unrestricted areas to determine that the levels are ALARA.

(d) Other Reviews. The RSO will review, as required, the internal radiation exposures of radiation workers to determine that their exposures are ALARA in accordance with the provisions of this program.

(2) Educational Responsibilities for an ALARA Program.

(a) The RSO will schedule briefings and educational sessions to inform workers of ALARA program efforts.

(b) The RSO will ensure that Authorized Users, workers, and individuals who may be exposed to radiation are instructed in the ALARA philosophy and informed that the Director, RSC, and the RSO are committed to the ALARA concept.

(3) Cooperative Efforts for the Development of ALARA Procedures. Radiation workers will be provided opportunities and encouraged to participate in the formulation of the procedures that they will be required to follow.

(a) The RSO will maintain close contact with Authorized Users and workers in order to develop ALARA procedures for working with radioactive materials and other sources of ionizing radiation.

(b) The RSO will receive and evaluate the suggestions of individual workers for improving radiation safety practices and encourage the use of those procedures.

(4) Reviewing and Reporting Instances of Deviation from Good ALARA Practices.

(a) The RSO will investigate all known or suspected deviations from good ALARA practices and, if possible, determine the cause. When the cause is known, the RSO will require changes in the program to maintain exposures ALARA.

(b) The RSO will report all significant deviations from good ALARA practices to the RSC for review.

d. Authorized Users.

(1) New Methods/Procedures Involving Potential

Radiation Doses.

(a) The Authorized User will consult with the RSO and/or RSC during the planning stage before using radioactive materials for new uses.

(b) The Authorized User will evaluate all aspects of the procedure to ensure that exposures will be kept ALARA. This may be enhanced through the application of trial runs.

(c) The Authorized User will amend (by the submission of documentation to the RSC for the new procedure) his Radiation Authorization before performing the new procedure.

(2) Authorized User's Responsibility to Supervised Individuals.

(a) The Authorized User will explain the ALARA concept and his commitment to maintain exposures ALARA to these personnel.

(b) The Authorized User will ensure that workers who are subject to occupational radiation exposure are trained and educated in good radiation safety practices and in maintaining exposures ALARA.

e. Individuals Who Receive Occupational Radiation Doses.

(1) Workers will be instructed in the ALARA concept and its relationship to work procedures and work conditions.

(2) Workers will be instructed in recourses available if they feel that ALARA is not being promoted on the job.

5. Establishment of Investigational Levels in Order to Monitor Individual Occupational Radiation Exposures.

a. The following Investigational Levels are established for occupational radiation exposure to individuals which, when exceeded, will initiate an investigation by the RSO.

(1) Investigation Level I.

(a) External exposure. Quarterly exposures for adults are 100 mrem to the whole body, 1.25 rem for shallow-dose and 375 mrem to the lens of the eye. Quarterly exposures for minors and declared pregnant workers are 10% of the adult exposures, excluding the quarterly whole body exposure of 50 mrem

for minors and the monthly whole body exposure of 25 mrem for declared pregnant workers.

(b) Internal exposure. When an adult receives an intake in excess of 10% of the ALI ıd a minor or declared pregnant worker receives a committed effective dose equivalent in excess of 0.050 rem (0.5 mSv) during any calendar year.

(2) Investigational Level II. These levels are established at three times the levels of Investigational Level I.

b. The following actions are required for the specified Investigational Levels.

(1) Personnel exposures less than Investigational Level I. No action is required unless determined by the RSO.

(2) Personnel exposures equal to or greater than Investigational Level I, but less than Investigational Level II. The RSO will investigate these exposures and submit a report to the RSC. The RSC is not required to take action for these exposures unless deemed otherwise. The RSC will, however, consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the RSC minutes.

(3) Personnel exposures equal to or greater than Investigational Level II. The RSO will investigate the cause(s) for these exposures and take action, if required. The RSO's investigative report, actions taken and a copy of the individual's radiation exposure record will be presented tc the RSC for review. The details of these reports and the RSC's recommendations and actions, if any, will be recorded in the RSC minutes.

(4) Re-establishment of an individual occupational ᵂ ker's Investigational Level II above that listed in paragrapl. ɔa(2).

(a) In cases where a worker's or a group of workers' exposures need to exceed Investigational Level II, a new, higher Investigational Level II may be established on the basis that it is consistent with good ALARA practices for the individual or group. Justification for a new Investigational Level II will be documented.

(b) The RSC will review the justification for and will approve all revisions of Investigational Levels II. In such cases, when the exposure equals or exceeds any newly established Investigational Level II, those actions specified in paragraph F5b(3) above will be followed.

G. Prenatal radiation surveillance program.

1. A "declared pregnant woman" is a radiation worker who has voluntarily informed, in writing, her supervisor of her pregnancy and the estimated date of conception.

2. At the time of declaring her pregnancy, the worker will consult the RSO, who will:

a. Ensure that the worker has read her copy of USNRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" with Appendices A and B, that was previously provided and answer any questions that she might have; and

b. Review, with the worker, her radiation exposure history (if applicable), advise her of potential risks due to occupational radiation exposure, counsel her in precautionary procedures to minimize the exposure to her and the fetus, and inform her that if she continues her normal duties in her current working environment, the radiation dose equivalent to the fetus (dependant upon the time of declaration of the pregnancy) will not exceed 500 millirem for the entire gestation period.

3. The worker will be requested to acknowledge by a signed statement the above information and will be provided a copy of that acknowledgement.

4. The worker and her supervisor will make every reasonable effort to minimize additional exposure to the worker. The worker may consult her supervisor for advice if she desires not to perform duties involving exposure to radiation or radioactive materials.

H. Medical surveillance program.

Previous and current radiation exposures received by monitored personnel and the types and quantities of radionuclides used and handled by personnel negates the need for a medical surveillance program for radiation workers. Clinical effects can not be observed nor expected for the radiation exposures received. Under special circumstances, the RSO may require the medical evaluation of a worker due to a known/suspected overexposure to radiation. EPA personnel involved with radiological emergency response teams may need to participate in some type of medical monitoring program.

I. Procurement, receipt, transfer and shipment of radioactive materials and equipment that produces ionizing radiation. The RSO will approve the procurement, receipt, transfer (including in/out of CRD-LV and between Authorized Users) and shipment of radioactive materials and equipment that produces ionizing radiation.

1. Procurement. In this context, "procurement" means the purchase of any radioactive material or equipment that produces ionizing radiation, regardless of radioactivity, through CRD-LV's, or a non-CRD-LV, purchasing agent and/or the receipt by transfer from a non-CRD-LV activity/supplier of a gift, donated or loaned, or demonstration sample, or any other receipt regardless of any monetary transaction involved.

a. Only an Authorized User or his representative can request and procure those radionuclides currently specified in his Radiation Authorization. The Authorized User will ensure that the material being requested is authorized and the requested quantities, in addition to the amounts he has on-hand (including waste), will not cause him to exceed the limits specified in his Radiation Authorization.

b. All procurement requests will be approved by the RSO by signature. Procurement personnel will not honor an unauthorized purchase request for radioactive materials.

c. Shipments of radioactive materials will be addressed to EPA, CRD-LV, Chemistry Lab Receiving, 944 E. Harmon Avenue, Las Vegas, NV 89119-6721. Electronic and other larger items of equipment will be addressed to EPA, 3201 Sunrise Avenue, Las Vegas, NV 89101. The RSO is to be consulted concerning special shipments.

d. Procedures. The Authorized User will:

(1) Contact the RSO to obtain an RS number for each radionuclide/shipment and provide the requested information;

(2) Prepare and ensure the procurement request contains, at a minimum, the Authorized User's name and signature, CRD-LV's delivery address, supplier's name and address, the phrase "RADIOACTIVE MATERIALS," RS#, radionuclide and its activity; and

(3) Forward the purchase request to the RSO for approval, who will forward the request to purchasing personnel.

e. Any deviation from the above cited procedures requires the RSO's approval prior to the deviation.

2. Receipt of packages.

a. All packages, whether or not they contain radioactive materials, are delivered to CRD-LV only during normal working hours; packages are not delivered or received after duty hours.

b. Monitoring the external surfaces of packages is

required for the following types of packages containing radioactive materials and will be performed as soon as practicable, but not later than 3 hours after the package is received.

(1) Packages known to contain radioactive material that have evidence or degradation of package integrity (crushed, wet, damaged, etc.) will be monitored for radioactive contamination and radiation levels.

(2) Packages containing quantities of radioactive materials that are in excess of the Type A quantity, as defined in 10 CFR 71.4 and Appendix A to 10 CFR Part 71, will be monitored for radiation levels.

(3) Packages labeled with a Radioactive White I, Yellow II, or Yellow III, unless the package contains only radioactive material in the form of a gas or in special form (as defined in 10 CFR 71.4), will be monitored for radioactive contamination.

c. The Authorized User, the User's authorized radiation workers, and RSO are authorized to receive and monitor packages.

d. Procedures for receiving packages.

(1) Don gloves if contamination is suspected and visually inspect the package. Verify that the designated receiver of the package as specified on the shipping label is correct.

(2) Perform the required monitoring if the package is labeled as Radioactive White I, Yellow II or III, contains quantities of radioactive materials in excess of the Type A quantity or is crushed, damaged or wet.

(3) Monitoring the external surfaces of the package will be performed by:

(a) The use of an appropriate, calibrated radiation survey instrument to determine the radiation levels; and/or

(b) Wiping an area of 300 cm^2 on the surface with an absorbent material, using moderate pressure, and measuring the activity on the wiping material to determine the non-fixed (removable) radioactive contamination. The results of the wipe can be obtained either by counting the wipe in a calibrated counting instrument or by using, in a low-background area, an appropriate, calibrated radiation survey instrument.

(4) Immediately notify the RSO and discontinue procedures if the monitoring results indicate that:

(a) Radiation levels at any one point on the external surface of the package exceed 200 millirem/hour (2 mSv/hr) or the Transport Index as annotated on the Radioactive Yellow II or III label exceeds 10; or

(b) Removable contamination activity (averaged over the surface wiped) on the external surface of the package exceeds:

- 22.0 dpm/cm^2 or 10^{-5} $\mu Ci/cm^2$ for beta-gamma emitting radionuclides, all radionuclides with half-lives less than 10 days, U-natural, U-235, U-238, Th-natural, Th-232, Th-228 and Th-230 when contained in ores or physical concentrates; or

- 2.2 dpm/cm^2 or 10^{-6} $\mu Ci/cm^2$ for all other alpha emitting radionuclides.

(5) Open the package and remove the packaging material and the source. Verify the contents with the shipping documents.

(6) Perform monitoring of the packaging material and source if contamination is suspected and decontaminate as required. Items contaminated will be disposed as radioactive waste.

(7) Prior to the disposal of uncontaminated packages, packaging material, etc. into the normal trash, remove or deface the radioactive label, radiation symbol and the words "radioactive materials" or otherwise indicate that the item no longer contains radioactive materials.

(8) Check gloves (and hands) for contamination and dispose accordingly.

(9) Immediately notify the RSO of discrepancies.

(10) Document the receipt of the package on the radioisotope receipt report and forward the report to the RSO. Initiate an accountability record for the radionuclide(s).

3. Transfer of radioactive materials and equipment that produces ionizing radiation.

a. All incoming, outgoing and within CRD-LV transfers will be approved by the RSO prior to the transfer and will be accomplished only by an Authorized User and/or the RSO.

b. All incoming transfers, including equipment

containing radiation sources or producing ionizing radiation, will be treated as a "procurement" as the RSO will assign an RS# for the radionuclide and its transfer.

c. Outbound transfers will comply with applicable parts in 10 CFR and 49 CFR (DOT) requirements for the shipping, labeling, monitoring and transportation of the material. Such transfers will only be performed to persons or activities licensed to receive and possess the radioactive material; verification of such will be in accordance with 10 CFR 30.41.

d. The RSO will be notified and approval obtained prior to the outbound transfer of any radioactive material, source or equipment that produces ionizing radiation to a vendor for repair, replacement or disposal.

4. Shipment of radioactive materials.

a. All shipments and the transportation of shipments of radioactive material will be approved by the RSO.

b. The requirements, and exemptions from requirements, for packaging and description, marking and labeling, placarding of vehicles, monitoring for radiation levels and radioactive contamination, modes of transportation, shipping papers, accident reporting and record keeping will be in accordance with applicable parts in 10 CFR and 49 CFR Parts 171 through 180.

J. Accountability and inventory of radioactive material and equipment that produces ionizing radiation.

1. As custodian of all radioactive materials and sources of ionizing radiation, the RSO will ensure that the total inventory of each radionuclide on-hand does not exceed the possession limits specified in CRD-LV's NRC license.

2. Each Authorized User will:

a. Maintain an accurate and complete inventory of all radioactive material, including that amount in waste that he has generated, in his possession and ensure that his quantities on-hand do not exceed the possession limits specified in his Radiation Authorization. Quantities in excess of possession limits will be provided to the RSO for storage;

b. Maintain an accountability record of all radioactive material that is received, used, and lost through radioactive decay, disposal or shipment; and

c. Physically perform a semiannual inventory of all his radioactive materials, including sealed sources, and

equipment that produces ionizing radiation, and provide the inventory to the RSO.

3. The inventory will specify each radionuclide, its RS# and date of receipt (if known), current (decayed) activity, location, the date the inventory was performed, and the name of the person(s) who performed the inventory. The inventory of sealed sources and equipment that produces ionizing radiation will include the manufacturer, model and serial number of the source and equipment (if known).

K. Leak testing of sealed sources.

1. Sealed sources and detector cells will be tested for leakage and/or contamination at intervals not to exceed 6 months or at other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

2. Notwithstanding the preceding paragraph, sealed sources designed to emit alpha particles will be tested for leakage and/or contamination at intervals not to exceed 3 months.

3. In the absence of a certificate from a transferor indicating that a leak test has been performed within 6 months prior to the transfer, a sealed source or detector cell received from another person will not be used until tested.

4. Each in-house fabricated sealed source will be inspected and tested for construction defects, leakage and contamination prior to any use or transfer as a sealed source.

5. Sealed sources need not be leak tested if:

a. They contain only hydrogen-3 or a radioactive gas;

b. The half-life of the isotope is 30 days or less;

c. They contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

d. They are not designed to emit alpha particles, are in storage, and are not being used. When they are removed from storage for use or transfer to another person, and have not been tested within the required leak test interval, they will be tested before use or transfer. No sealed source or detector cell will be stored for a period of more than 10 years without being tested for leakage and/or contamination.

6. The leak test will be capable of detecting the presence of 0.005 microcuries of radioactive material on the test sample. The results of all leak tests will be annotated in microcuries.

7. Sealed sources or detector cells containing licensed material will not be opened or sources removed from the source holder.

8. The RSO will:

a. Perform or ensure the performance of leak tests and maintain records as required;

b. Immediately remove from service a source indicating the presence of 0.005 microcurie or more of removable contamination and decontaminate, repair, or dispose of the source; and

c. File a written report to the NRC within 5 days after the date the leak test result is known.

L. Radioactive detectors in gas chromatography.

1. General.

a. Gas chromatographs with electron capture detectors contain sealed sources such as Nickel-63 or Hydrogen-3.

b. Sealed sources or detector cells will not be opened or sources removed from the source holder by personnel.

c. The maintenance, repair, cleaning, replacement and disposal of foils contained in detector cells will be performed only by the device manufacturer or persons specifically authorized by the NRC, Agreement or Licensing State to perform such services.

d. The removal, handling and transfer of the source and its container to a vendor for repair, replacement or disposal will be coordinated with and approved by the RSO.

e. When not physically installed in the unit, sources and their containers will be labeled as required, controlled and secured to prevent unauthorized removal.

f. Detector cells containing a titanium tritide foil or a scandium tritide foil will:

(1) Only be used in conjunction with a properly operating temperature control mechanism which prevents the foil temperature from exceeding that specified by the manufacturer and approved by the NRC; and

(2) Be vented to the outside when in use.

g. Associated hazards are both external and internal

exposure, however external hazards are generally non-existent and therefore personnel are not issued dosimeters. The degree of hazard dependents upon the radionuclide, activity, encapsulation and the operating factors involving the use of the source.

2. Instrument operation.

a. The Authorized User is responsible for the safe and proper operation of the unit and will ensure that his authorized radiation workers have been adequately trained in the usage and safety procedures for the instrument.

b. All safety and control devices will be checked for complete operability at least annually and after a source has been replaced.

c. The unit will not be operated at temperatures greater than the manufacturer's specifications.

d. Whenever there is suspect that the high-temperature-limit devices have malfunctioned or otherwise permitted the detectors to be heated above their maximum operating temperature, the unit will be turned off and the RSO notified immediately.

M. Radiological emergencies.

1. General.

a. Radiological emergency procedures should be posted in usage and storage areas, will be immediately available to personnel at all times, and are required to prevent, control or reduce accidental radiation exposure and/or contamination to workers and the public.

b. All radiation workers will be knowledgeable in the emergency procedures and relative radiotoxicity and health hazards of the radionuclides in their possession.

c. The most senior individual present will assume control of the situation and direct activities until relieved by the RSO. The exact actions and sequence of actions to be taken will be determined by the nature of the emergency.

2. Notifications. All radiological emergencies will be immediately reported to the Safety, Health and Environmental Maager (SHEM) and the RSO, who will:

a. Respond to supervise the elimination of radiological hazards to personnel, equipment and the environment; and

b. Initiate, make, or coordinate all follow-up actions, investigations, reports and notifications with the cooperation of the individual(s) involved.

3. Minor spill (minimum hazard).

a. Notify all individuals in the area that a spill has occurred.

b. Using protective attire, confine and control the spill. Cover a liquid spill with absorbent material and a dry spill with dampened absorbent material. Neutralize the spill, if required.

c. Mark off the contaminated area with tape, chalk, rope, etc. and control and restrict access to the area.

d. Notify the RSO and SHEM.

e. Establish a plan and start decontamination procedures.

4. Major spills involving radiation hazards.

a. Notify all individuals not required to control the spill to immediately vacate the room.

b. Eliminate or limit the spread of contamination and the source of radiation by the use of protective attire.

(1) Return the source to a shielded container or location.

(2) Confine and control the spill. Cover a liquid spill with absorbent material and a dry (powder) spill with dampened absorbent material. Neutralize the spill, if required.

(3) Turn off all fans.

c. Vacate the room. Ensure that all access doors are closed, secured and controlled to prevent access to the room.

d. Notify the RSO and SHEM.

e. Monitor all individuals suspected of contamination and decontaminate individuals who are contaminated.

5. Accidents involving radioactive aerosols.

a. Notify all individuals in the area that a radioactive aerosol accident has occurred and to immediately

vacate the room.

b. Hold breath, cover the container dispersing the aerosol and vacate the room.

c. Ensure that all access doors are closed, secured and controlled to prevent access to the room.

d. Notify the RSO and SHEM.

e. Monitor all individuals suspected of contamination and decontaminate individuals who are contaminated.

6. Personal injury involving radioactive materials.

a. Minor injury.

(1) Immediately flush or wash the injured area with copious amounts of warm water, manipulating the wound to promote bleeding and good rinsing.

(2) Administer first aid, as appropriate.

(3) Notify the RSO, SHEM and (if required) medical personnel.

b. Major injury.

(1) Notify medical service personnel, the RSO and SHEM. Provide radiological hazard information to medical service personnel and remain with the injured individual until relieved by the RSO.

(2) Administer appropriate first aid to the individual as the medical stability of the individual takes precedence over the contamination. If feasible, flush or wash the injured area with warm water several times, cover the wound with absorbent material and then with a plastic covering to prevent cross-contamination.

7. Equipment that produces ionizing radiation. Disconnect the electrical power supply to the unit, perform the emergency procedures specified in the operator's manual, and notify the RSO.

8. Lost or missing radioactive materials or sources. Immediately report to the RSO the loss, missing or theft of any radioactive material or radiation source.

9. Fire procedures.

a. If a fire extinguisher is readily available,

radiological hazards do not exist, and the fire is small and controllable, attempt to extinguish the fire.

b. Activate the fire alarm to evacuate the building and summon the Fire Department.

c. Initiate the Emergency Evacuation Plan.

d. Contact or leave a message for the RSO and SHEM.

e. Locate the Officer-in-Charge of the responding Fire Department and provide radiological information.

N. Determining compliance with 40 CFR 61 Subpart I regarding air effluents. Guidance for determining compliance with 40 CFR 61 Subpart I is found in the Federal Register, Rules and Regulations, Volume 54, Number 240, Friday, December 15, 1989, pages 51697 through 51715, and in EPA 520/1-89-002, "A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Facilities," Revision 2, dated October 1989. The current method used by the RSO is the performance of calculations based upon the "annual possession quantities." To date, this facility has been exempt from filing a report with EPA; thus demonstrating compliance with the standard.

Item 11. Waste Management.

1. General. This facility generates little radioactive waste, including liquid scintillation vials, and dispersible liquid waste which is emptied into the sewerage system. When warranted for shipment, the waste is packaged and shipped by a licensed broker to an authorized burial site for ultimate disposal. The treatment or disposal by incineration or burial of radioactive waste is not performed, nor authorized.

2. Responsibilities.

a. The RSO is responsible for the control, management and disposal of all radioactive waste.

b. The SHEM is responsible for the management and disposal of mixed radioactive materials containing hazardous materials.

c. The Authorized User will:

(1) Maintain an inventory of the radioactive waste in his possession and documented records for all disposals of radioactive waste, including liquid scintillation vials;

(2) Secure, control, segregate, store, dispose

and/or package his waste as required by the RSO and SHEM;

(3) Provide appropriate containers for waste and ensure all containers are identified and labeled as required; and

(4) Obtain approval from the RSO prior to any local disposal of waste into the sewerage system or relinquishing custody of mixed waste to the SHEM for disposal.

3. Radioactive materials containing hazardous materials, as defined in 40 CFR Part 261, will be disposed by the SHEM and RSO.

4. The following disposals of radioactive waste containing non-hazardous materials are authorized. Other methods for disposal require approval by the RSC.

a. Decay in storage. Short-lived radionuclides (half-lives of 70 days or less) are held for ten half-lives and, after monitoring has been performed to verify that background radiation levels are not exceeded and the removal or defacing of all radiation labels, symbols, or the words "radioactive materials," are disposed as non-radioactive waste.

b. The release of soluble and readily dispersible biological materials into the sanitary sewerage system. The quantities released will not exceed the average monthly concentrations specified in Table 3, Appendix B, 10 CFR 20.1001 - 20.2401. The total quantity released in a year will not exceed 5 curies (185 GBq) of Hydrogen-3, 1 curie (37 GBq) of Carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

c. The disposal of specific wastes as if the waste is not radioactive. Authorized for disposal is 0.05 microcuries (1.85 kBq), or less, of Hydrogen-3 or Carbon-14 per gram of medium used for liquid scintillation counting.

d. Radioactive solutions may be precipitated or evaporated to dryness and then treated as solid waste.

e. The transfer of waste by an authorized and licensed broker who will package and transport the waste to a licensed facility authorized to receive, store, and dispose of the waste. The shipment and transportation of radioactive waste will be performed in accordance with applicable parts in 10 CFR and DOT regulations, 49 CFR Parts 171 through 180.

5. All radioactive waste will be segregated from non-radioactive waste to ensure that the radioactive waste on-hand is kept to a minimum. All containers of radioactive waste will be labeled and identified as required and segregated as follows.

a. Liquid waste will be segregated from solid waste.

(1) Liquid waste retained for disposal should be collected in plastic bottles or sealed, leak-proof cans to reduce possible breakage. Liquid waste which chemically or otherwise reacts with plastic should be placed in glass bottles, which in turn should be placed into a plastic container to prevent spillage in case of droppage.

(2) Solid waste will be placed in plastic bags or a receptacle lined with a plastic bag. When filled and ready for removal, the opening of the bag will be secured with tape.

b. Radioactive waste will be segregated from mixed radioactive waste containing hazardous materials.

c. The longer-lived radionuclides should be segregated from the shorter-lived radionuclides to facilitate decay in storage and local disposal.

6. Records for all disposals will be maintained.

Curriculum Vitae

Loyd D. Carroll

Employment

Radiation Safety Officer/Health Physicist
U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division phone 702-798-2313
Las Vegas, Nevada 89193-3478
October 1991 - present

Public Health Physicist II
State of Florida, Dept of Health & Rehabilitation Service
Radiation Control, 400 W. Robinson, Suite S-529
Orlando, Florida 32801
August - October 1991

US Army 1975 - 1991

Chief, Health Physics Office (RSO)
Tripler Army Medical Center
Honolulu, Hawaii 96859
December 1986 - August 1991

Chief, Radioisotopes Branch (RSO) and QA Officer
Letterman Army Institute of Research
Presidio of San Francisco, California 94129
July 1983 - July 1986

Radiation Safety Officer (RSO)
General Leonard Wood Army Community Hospital
Fort Leonard Wood, Missouri 65473
September 1980 - July 1983

NCOIC, Nuclear Medicine Technologist (Alternate RSO)
General Leonard Wood Army Community Hospital
Fort Leonard Wood, Missouri 65473
September 1978 - July 1980

Nuclear Medicine Technologist
William Beaumont Army Medical Center
El Paso, Texas 79920
December 1977 - September 1978

Physical Scientist Assistant
US Army Nuclear Agency
Weapon Effects Division
El Paso, Texas 79919
March 1975 - August 1977

Enclosure 1

Curriculum Vitae (cont)

Loyd D. Carroll

Education/Schools

West Texas State University, BS in Biology, 1975
George Washington University, AS in Nuclear Medicine, 1981

Hazardous Waste Operations and Emergency Response Refresher Course, 7/9/96
Nuclear Emergency Search Team (NEST), 10-12/01/95
Transportation Emergency Training for Response Assistance (TETRA), 22-26/05/96
Hazardous Waste Operations and Emergency Response Course, 17-21/04/95
Contract Administration Course, 20-21/04/94
DOT Regulations Under HM-181 Course, 8-9/12/93
Radiological Worker I Course, 04/05/93
Environmental Radiation Monitoring Refresher Course, 22-23/10/92
Fundamentals of Radiological Health Physics, 13-18/01/92
Environmental Radiation Monitoring Refresher Course, 6-8/11/91
Medical Effects of Nuclear Weapons, 13-14/08/90
Good Laboratory Practices Course, 26-27/01/84
Nuclear Medical Science Officer Workshop, 17-21/10/83
Nuclear Medical Science Officer Workshop, 19-23/10/81
Integrating Hospital Quality Assurance, 29/09/81
Medical X-ray Survey Techniques Course, 11-22/05/81
Radiation Protection Officer Workshop, 14-18/04/80
Microwave Survey Techniques Workshop, 26-27/03/79
Leadership Management Development Course, 5-9/11/78
Clinical Nuclear Medicine Technician Course, Jan-Sep/78
Clinical Nuclear Medicine Technical School, Aug-Dec/77
Disaster Control Specialist Course, 24-27/04/67

Affiliations

Health Physics Society, Plenary Member since 1981
Nuclear Medicine Technology Certification Board, 1978

Personal

Married, Ht. 5' 9", Wt. 170 lbs, excellent health

References

Available upon request

FORM NRC-313M-SUPPLEMENT A
(8-78)

U.S. NUCLEAR REGULATORY COMMISSION

TRAINING AND EXPERIENCE
AUTHORIZED USER OR RADIATION SAFETY OFFICER

1. NAME OF AUTHORIZED USER OR RADIATION SAFETY OFFICER	2. STATE OR TERRITORY IN WHICH LICENSED TO PRACTICE MEDICINE
Loyd D. Carroll	

3. CERTIFICATION

SPECIALTY BOARD A	CATEGORY B	MONTH AND YEAR CERTIFIED C

4. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

FIELD OF TRAINING A	LOCATION AND DATE(S) OF TRAINING B	TYPE AND LENGTH OF TRAINING: LECTURE/ LABORATORY COURSES (Hours) C	TYPE AND LENGTH OF TRAINING: SUPERVISED LABORATORY EXPERIENCE (Hours) D
a. RADIATION PHYSICS AND INSTRUMENTATION	1. Nuclear Medicine Tech School US Navy, NNMC, Bethesda, MD August-December 1977 2. William Beaumont Army Med Ctr Nuclear Medicine Technician El Paso, TX 01-09, 1978 3. Ft. Leonard Wood Army Hospit. NCOIC, Nuclear Medicine Serv. Ft. Leonard Wood, MO 10/78-07/80 4. RSO at US Army Medical Centers and Research Center Aug 1980 - July 1991	1. 22 weeks 2. 9 months	3&4. 12 yrs
b. RADIATION PROTECTION	"	1. 22 weeks 2. 9 months	3&4. 12 yrs
c. MATHEMATICS PERTAINING TO THE USE AND MEASUREMENT OF RADIOACTIVITY	"	1. 22 weeks 2. 9 months	3&4. 12 yrs
d. RADIATION BIOLOGY	"	1. 22 weeks 2. 9 months	3&4. 3 yrs
e. RADIOPHARMACEUTICAL CHEMISTRY	"	1. 22 weeks 2. 9 months	3&4. 3 yrs

5. EXPERIENCE WITH RADIATION. *(Actual use of Radioisotopes or Equivalent Experience)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Atomic # 3-83	50 mCi each	US Army Medical and Research Centers	Jan 1978-July 1991	Medical/Therapy In vitro studies Research/Development
Tc99m/Mo99	6 Curies	"	"	"
I-125	500 mCi	"	"	"
I-131	2 Curies	"	"	"
Cs-137	5,000 Curies/sealed			
Co-60	9,000 Curies/sealed			

Enclosure 2

Curriculum Vitae

Gregg D. Dempsey, Chief
Field Studies Branch
Office of Radiation and Indoor Air
Las Vegas Facility

Education

University of Mississippi, B.A., 1978.
Double major in physics and zoology.

Work Experience

June 1989 to present:

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Las Vegas, Nevada
Chief, Field Studies Branch

Manage ORIA mobile laboratory response, recommend field studies, recommend radioanalyses, manage and direct data quality reviews. Assist EPA Region Superfund, RCRA, Federal Facility, and Radiation Programs Offices by providing radiation and health physics consulting services. Managed and direct the Las Vegas Facility's emergency and Superfund response. Serve as a senior member of ORIA emergency response staff in nuclear weapons, nuclear power plant, and other type of Federal response for incident and accident exercises.

Oct. 1987 to June 1989:

U.S. Environmental Protection Agency
Office of Radiation Programs
Las Vegas, Nevada
Environmental Scientist, Field Studies Branch

Served as Office of Radiation Programs - Las Vegas Emergency Response Coordinator. Duties included assessing condition of response readiness, recommending improvement where needed, and meeting with other groups in the federal government concerning emergency preparedness exercises dealing with accidents at commercial nuclear power plants and nuclear weapons accidents.

Enclosure 3

Nov. 1980 to
Oct. 1987: Mississippi State Department of Health
Division of Radiological Health
Environmental Monitoring and
Emergency Response Branch
Branch Director

Managed radiation laboratory that was responsible for Safe Drinking Water analysis for the state. Directed section responsible for environmental monitoring around nuclear facilities, former DOE sites, ambient radiation measurement in air due to fallout, and radioanalysis of community drinking water supplies within Mississippi. Emergency functions included response to nuclear incidents at nuclear power plants, transportation accidents, and elsewhere.

June 1979 to
June 1981: Mississippi State Board of Health
Division of Radiological Health
Health Physicist I/III

In Environmental Section, developed and maintained environmental monitoring at Grand Gulf Nuclear Station which included collection and analysis of various samples representative of the environment. Assisted in analysis and report preparation of the 1600 community drinking water supplies in Mississippi in accordance with the Safe Drinking Water Act.

Professional Associations:

- Health Physics Society
- Conference of Radiation Program Directors

Additional Training:

- Nuclear Regulatory Commission 10-Week Health Physics Course, Oak Ridge Associated Universities, 1980.
- Environmental Protection Agency Laboratory Radioanalysis of Public Drinking Water Supplies Course, Georgia Institute of Technology, 1982.
- Department of Energy Radiological Monitoring, Sampling and Analysis Course, Idaho National Engineering Laboratory, 1984.
- Department of Energy Fundamentals of Health Physics Review Course, DOE Nevada Operations Office, 1988.
- Additional Course Listings on Request.

Legal Recognition:

Accepted as radiation laboratory and environmental health physics expert by the litigants in the Street, Inc. v. Chevron, et. al. , 1991 legal case. This case concerned laboratory data, laboratory analyses, and data validation issues.

FORM NRC-313M-SUPPLEMENT A
(8-78)

U.S. NUCLEAR REGULATORY COMMISSION

TRAINING AND EXPERIENCE
AUTHORIZED USER OR RADIATION SAFETY OFFICER

1. NAME OF AUTHORIZED USER OR RADIATION SAFETY OFFICER	2. STATE OR TERRITORY IN WHICH LICENSED TO PRACTICE MEDICINE
Gregg D. Dempsey	

3. CERTIFICATION

SPECIALTY BOARD A	CATEGORY B	MONTH AND YEAR CERTIFIED C

4. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

FIELD OF TRAINING A	LOCATION AND DATE(S) OF TRAINING B	TYPE AND LENGTH OF TRAINING	
		LECTURE/ LABORATORY COURSES *(Hours)* C	SUPERVISED LABORATORY EXPERIENCE *(Hours)* D
a. RADIATION PHYSICS AND INSTRUMENTATION	1. Oak Ridge Assoc Univ, 1980 2. INEL Radiochemistry Course, 1982	1. 10 Weeks 2. 1 Week	3.8 years
b. RADIATION PROTECTION	3. Mississippi Dept of Health Radiological Health, 1979 - 1987	1. 10 Weeks 2. 1 Week	3.8 years
c. MATHEMATICS PERTAINING TO THE USE AND MEASUREMENT OF RADIOACTIVITY	4. Mississippi Dept of Health Radiological Health, 1979-1987	1. 10 Weeks 2. 1 Week	3.8 years
d. RADIATION BIOLOGY	5. Mississippi Dept of Health Radiological Health, 1979-1987	1. 10 Weeks 2. 1 Week	3.8 years
e. RADIOPHARMACEUTICAL CHEMISTRY			

5. EXPERIENCE WITH RADIATION. *(Actual use of Radioisotopes or Equivalent Experience)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Co-60	1 Ci	Ms State Dept of Health	1980-1987	Calibration Source
Cs-137	500 mCi	Ms State Dept of Health	1980-1987	Calibration Source
Cs-137	10 Ci	USEPA, Las Vegas, NV	1987-1996	Calibration Source
RA-226	5 mCi	USEPA, Las Vegas, NV	1987-1996	Calibration Source
Various	Various	Supervision of Radio-Chemistry Lab, MSDOH	1979-1987	Calibration

Enclosure 4

Professional Biography For:

Stephen H. Pia
Title and Grade: Research Chemist, GS 13

Education

1979 B.A. Chemistry, University Of Nevada Las Vegas

Additional Training

Date	Title	Hours
6/90	Public Health Service Hazard Communication	4
6/90	Environmental Radiation Monitoring	40
11/91	Environmental Radiation Monitoring Refresher	24
11/91	Counting Statistics	24
9/92	Professional Supervision Skills	8
10/92	Environmental Radiation Monitoring Refresher	8
11/92	PU Valley Drill ARG/FRMAC Training Drill	40
2/93	Hazardous Waste Disposal Training	2
8/93	Technical Writing	20
8/93	Environmental Statistics	16
11/94	DOT 49 CFR 172.700 Awareness Training	8
12/95	Annual Radiation Safety Briefing	1

Work Experience

6/89 - Present Chemist, U. S. Environmental Protection Agency EMSL-LV. Laboratory operations manager of EMSL-LV's Performance Evaluation Program's verification and standards laboratory.

9/85 - 6/89 Environmental Scientist, Lockheed Environmental Management Company

8/84 - 9/85 Chemist, Western Technology Inc.

7/79 - 8/84 Laboratory Supervisor, Kerr McGee Chemical Company

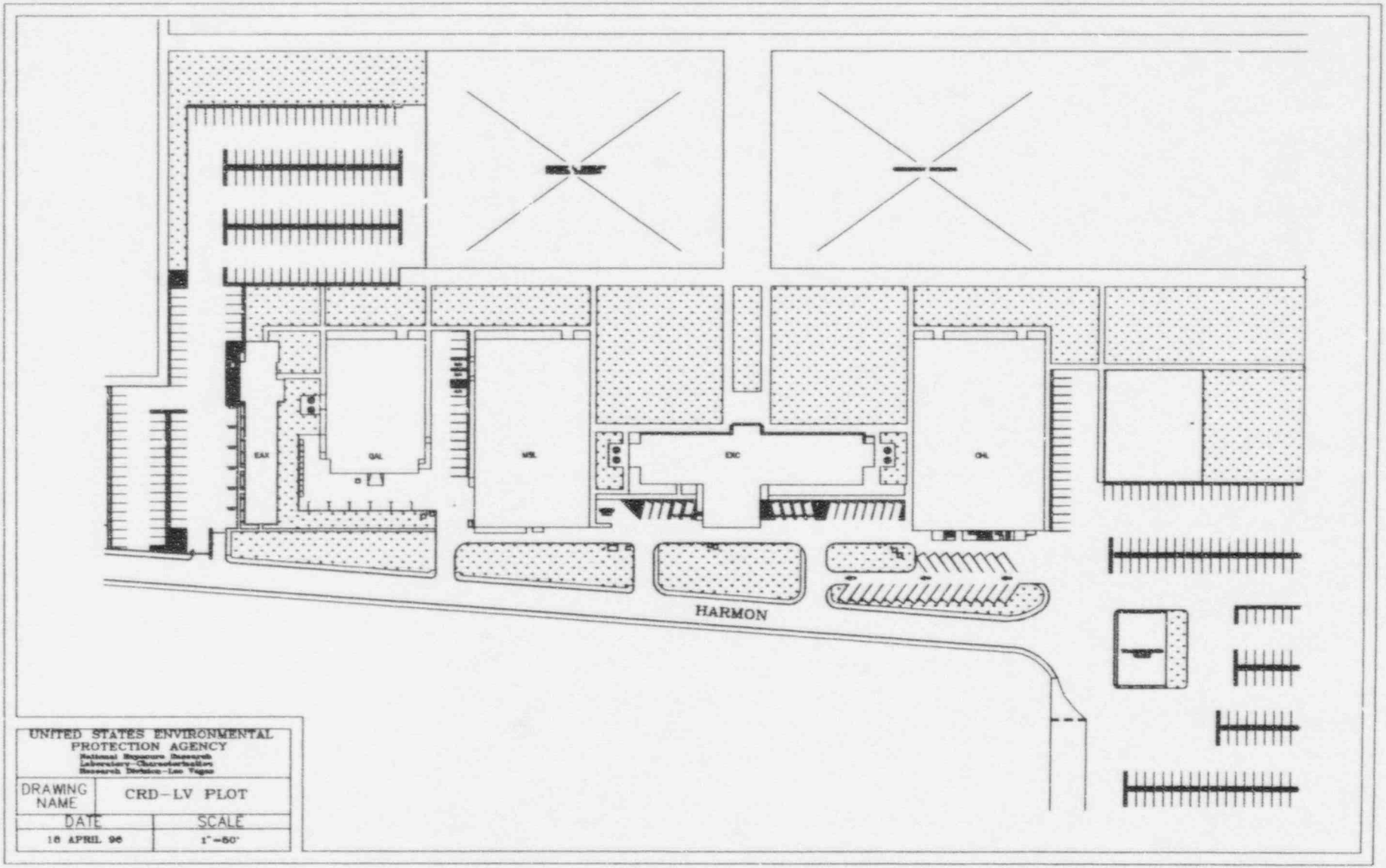
Professional Positions

6/94 - 4/95 Chairman Occupational Safety and Health Committee

11/93 - Present Chairman Standard Methods Task Group for Environmental Radiochemistry Methods

4/96 - Present Chairman CRD-LV Radiation Safety Committee

Enclosure 5


EAX
GAL
MSL
EXC
CHL
HARMON
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
National Exposure Research Laboratory - Characterization Research Division - Las Vegas
DRAWING NAME
CRD-LV PLOT
DATE
16 APRIL 96
SCALE
1"=50'

Enclosure 6

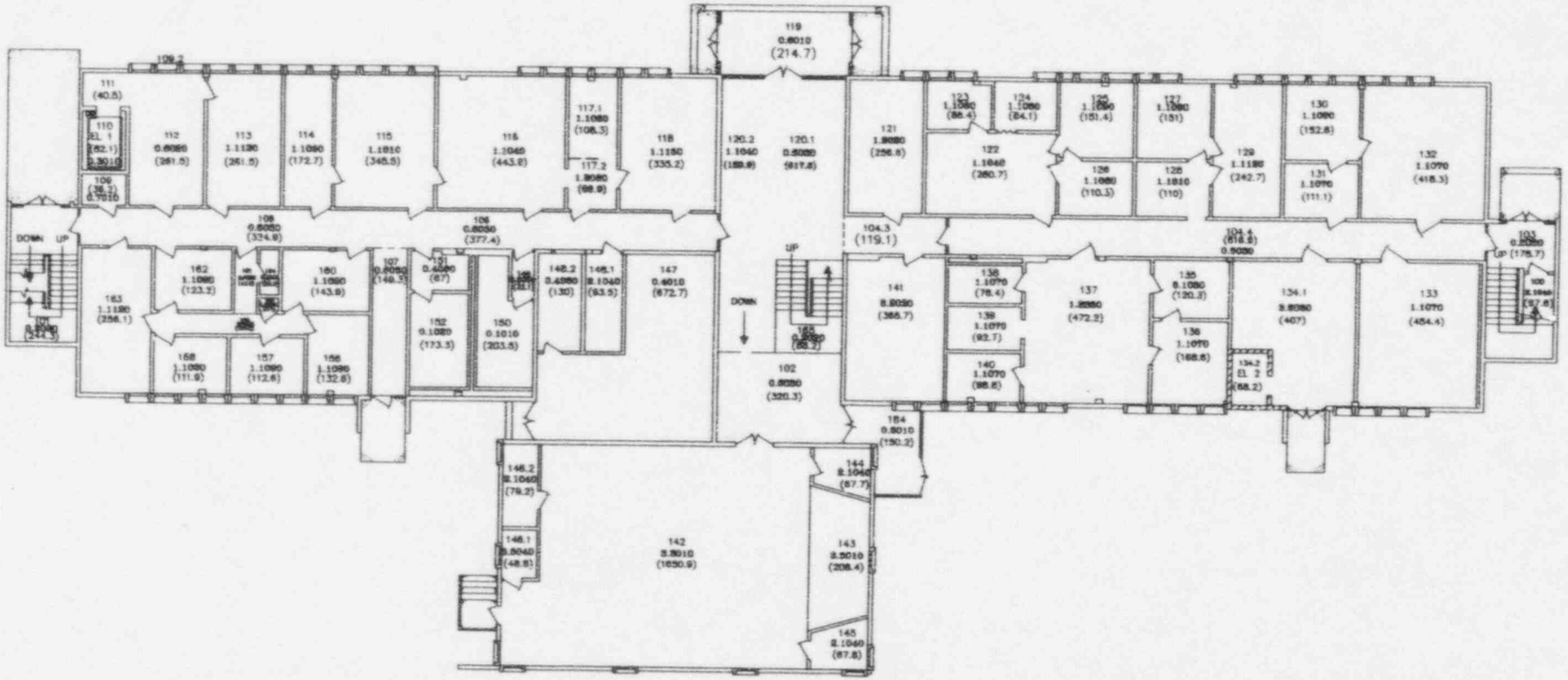
CHEMISTRY LABORATORY

U.S. ENVIRONMENTAL PROTECTION AGENCY

NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

04/18/96
Drawn by:
F.L.Childers

Enclosure 7



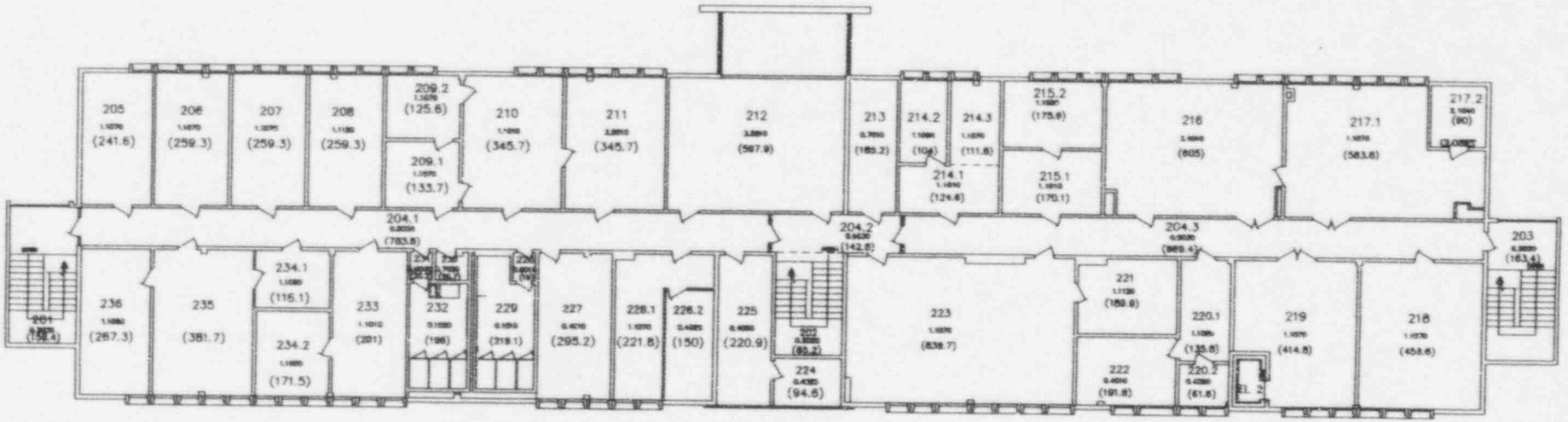
EXECUTIVE CENTER–1st FLOOR

U.S. ENVIRONMENTAL PROTECTION AGENCY

NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119–6721

04/18/96
Drawn By:
F.L.Childers

Enclosure 8

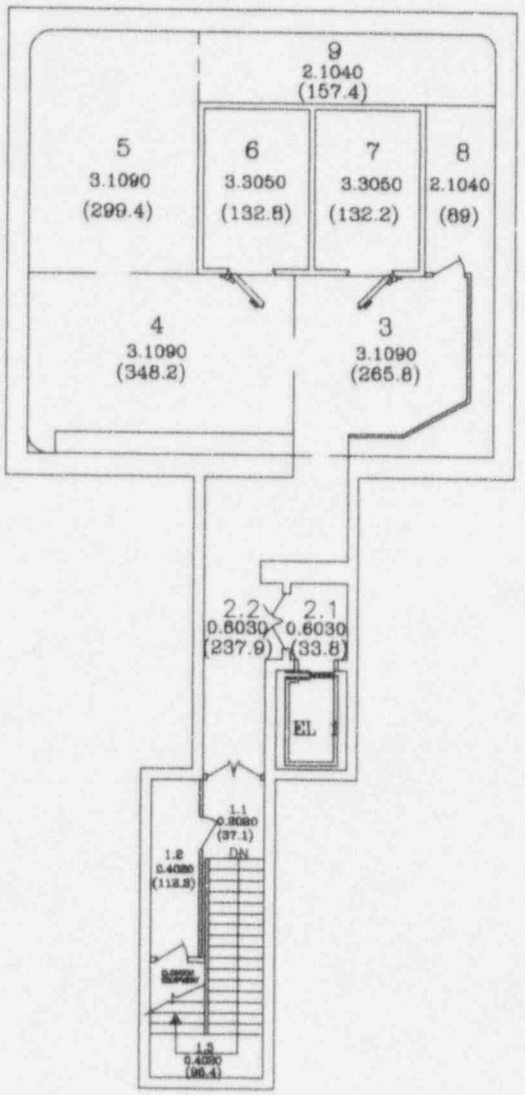


EXECUTIVE CENTER–2nd FLOOR

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

04/18/96
Drawn By:
F.L.Childers

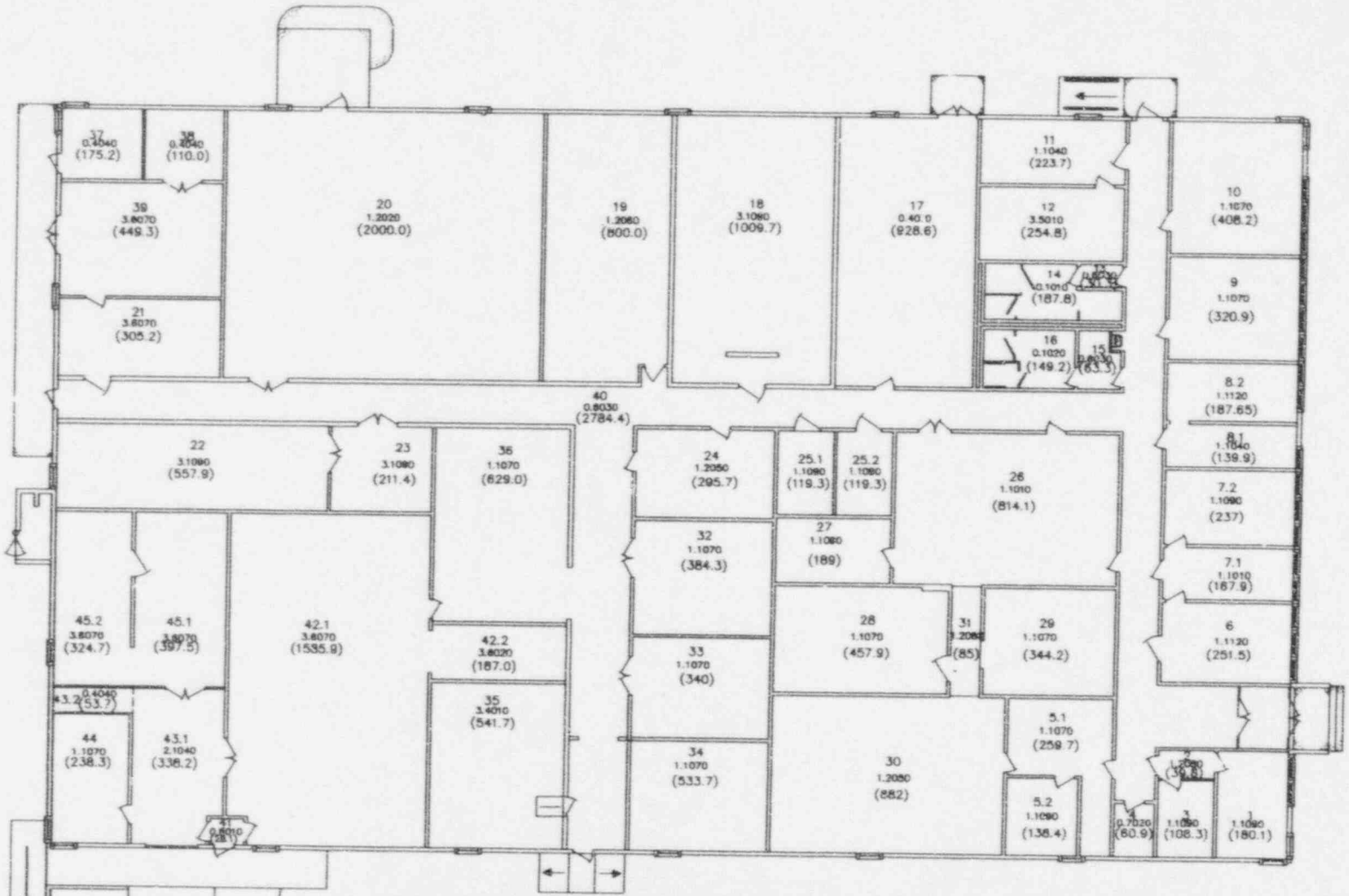
Enclosure 9



EXECUTIVE CENTER-VAULT

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

Enclosure 10

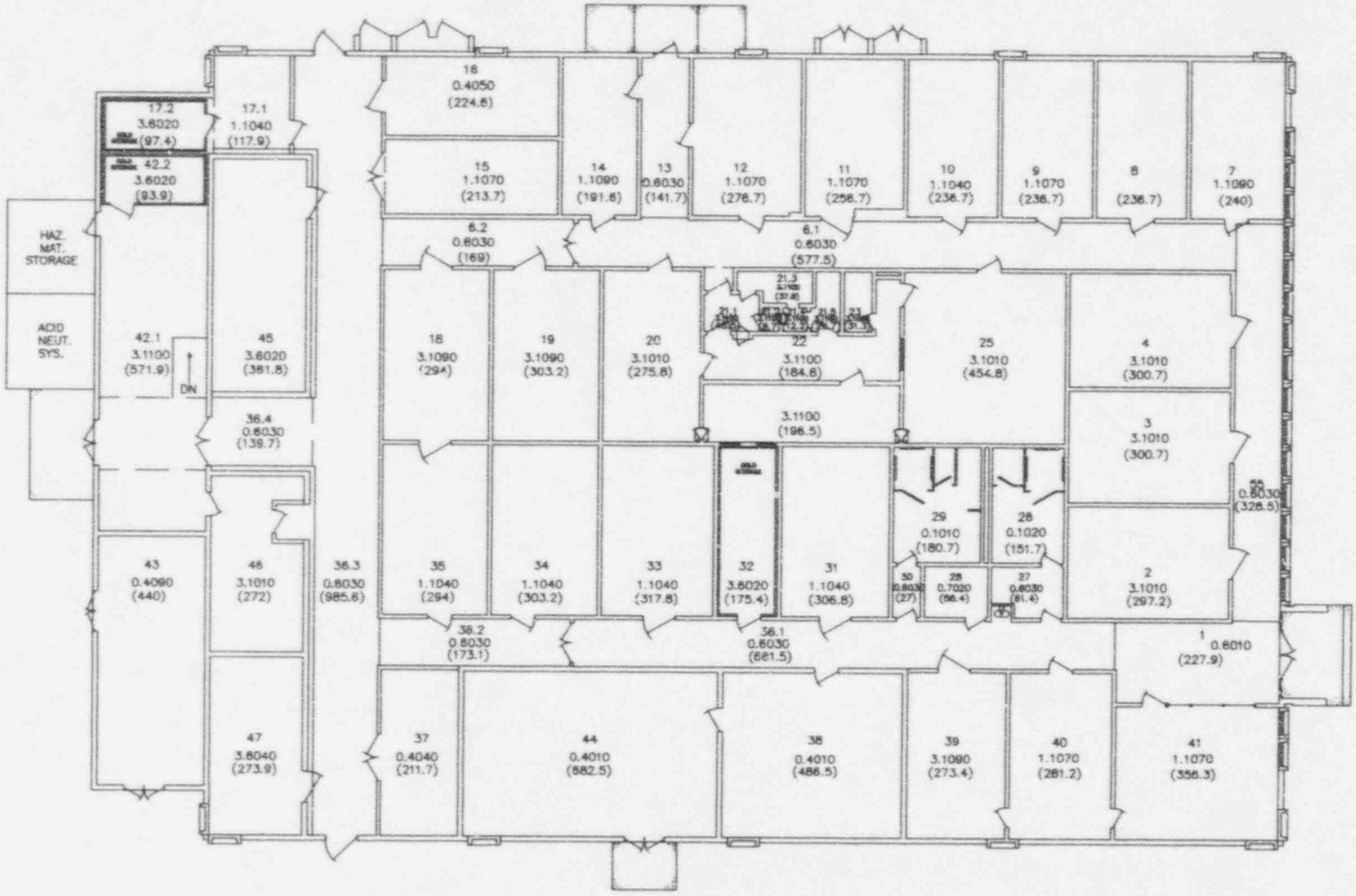


MONITORING SCIENCES LABORATORY

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

04/18/96
Drawn By:
F.L.Childers

Enclosure 11



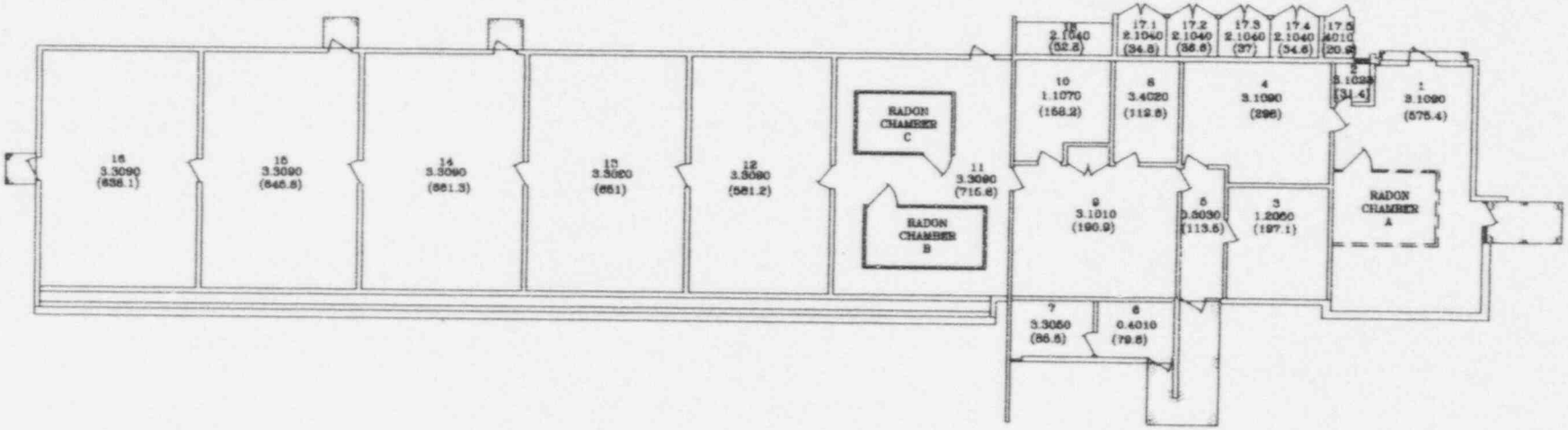
QUALITY ASSURANCE LABORATORY

U.S. ENVIRONMENTAL PROTECTION AGENCY

NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

04/18/96
Drawn By:
F.L.Childers

Enclosure 12



ENVIRONMENTAL ANNEX BUILDING

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

04/18/96
Drawn By:
F.L.Childers

Enclosure 13

MODULAR OFFICE COMPLEX

U.S. ENVIRONMENTAL PROTECTION AGENCY

NATIOAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119-6721

N
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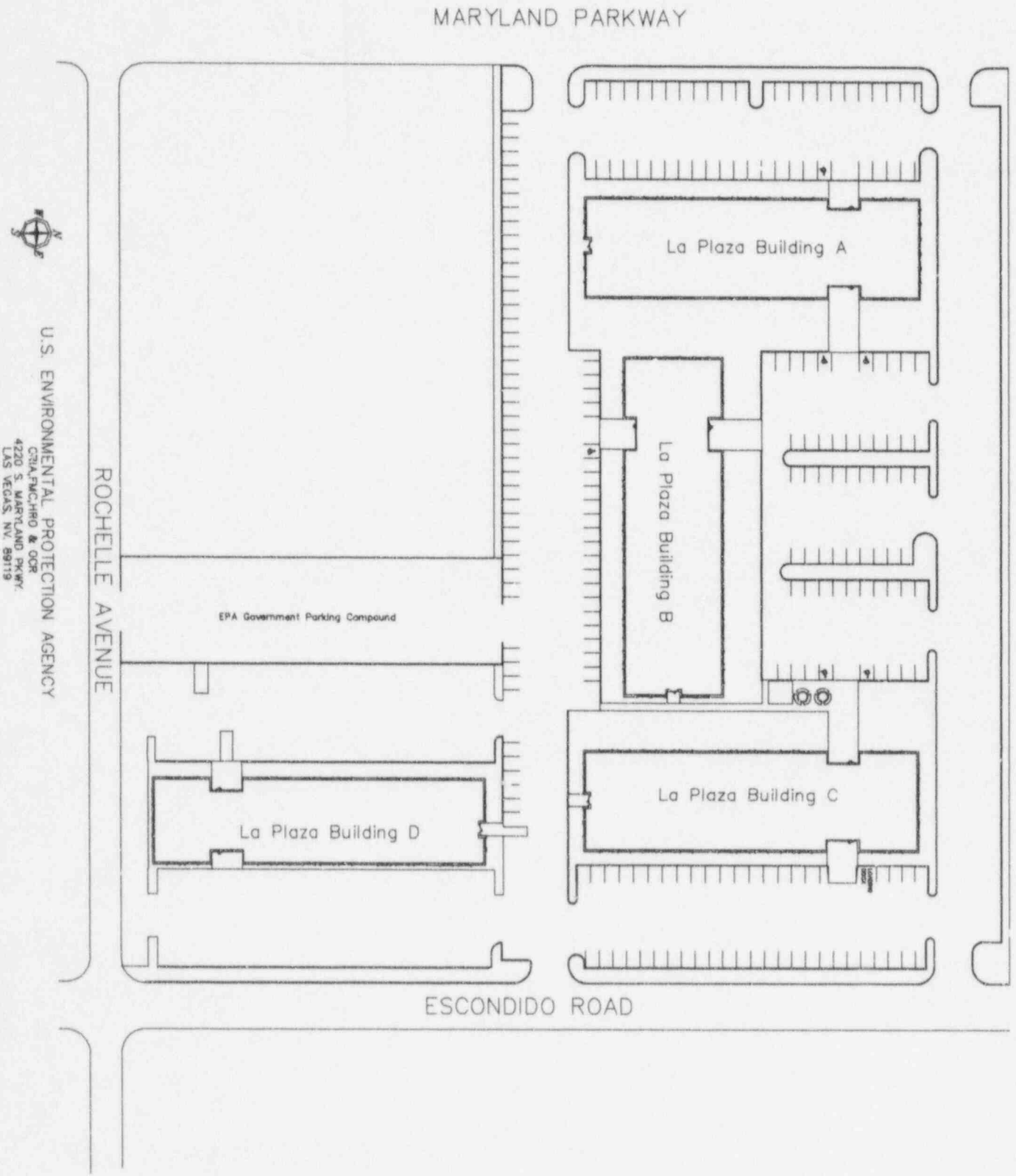
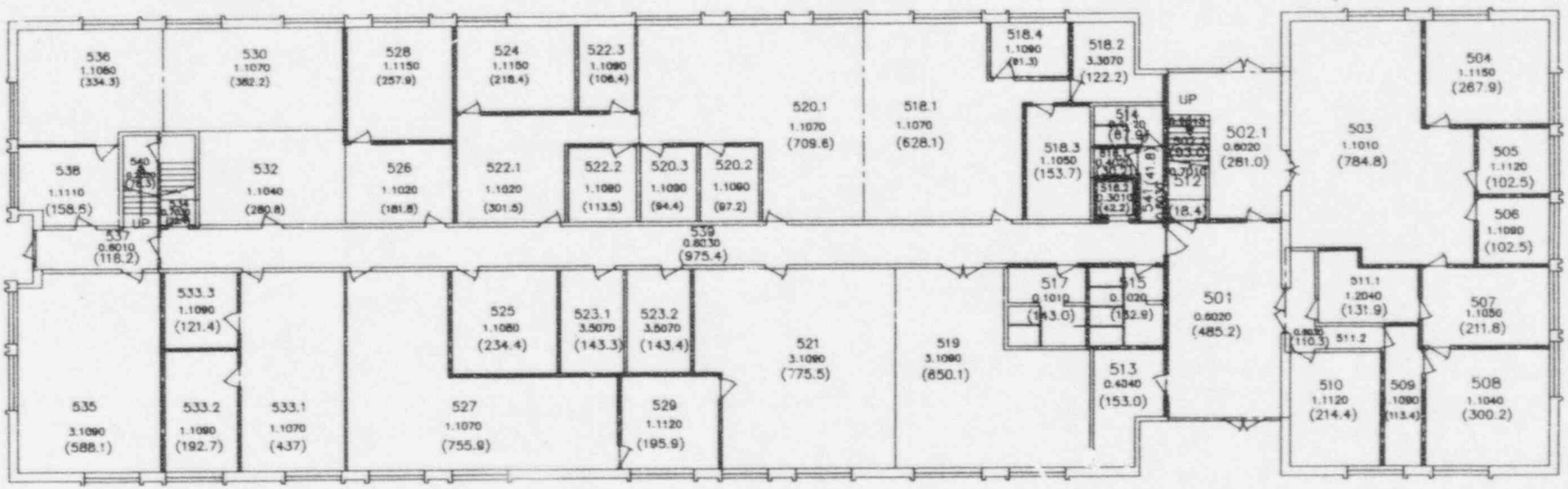
04/18/96
Drawn By:
F.L.Childers

Enclosure 14



Enclosure 15

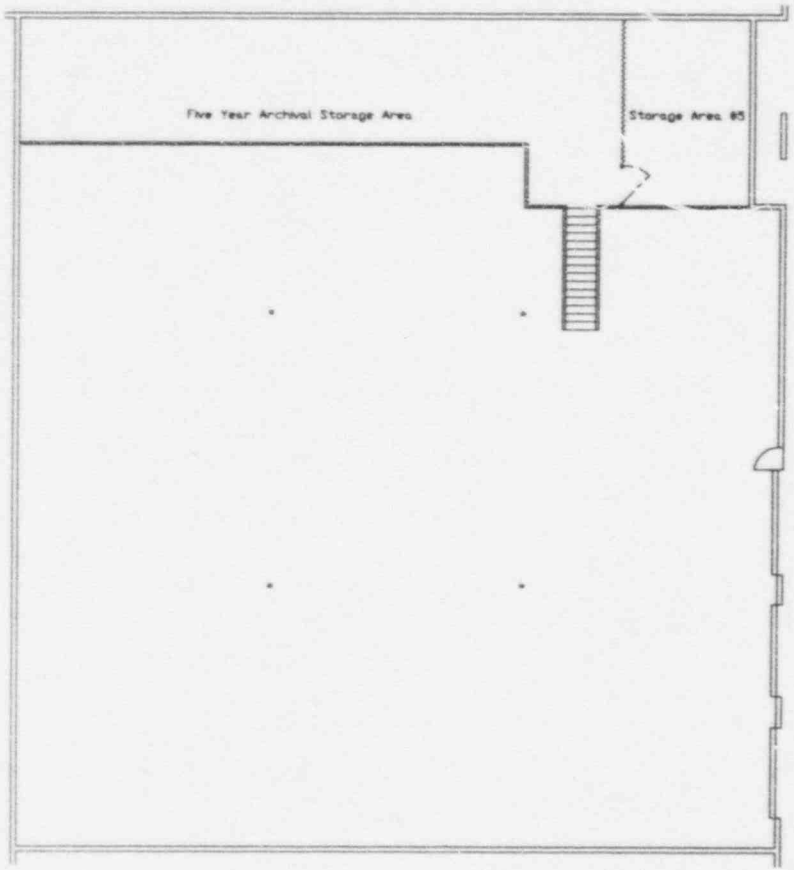


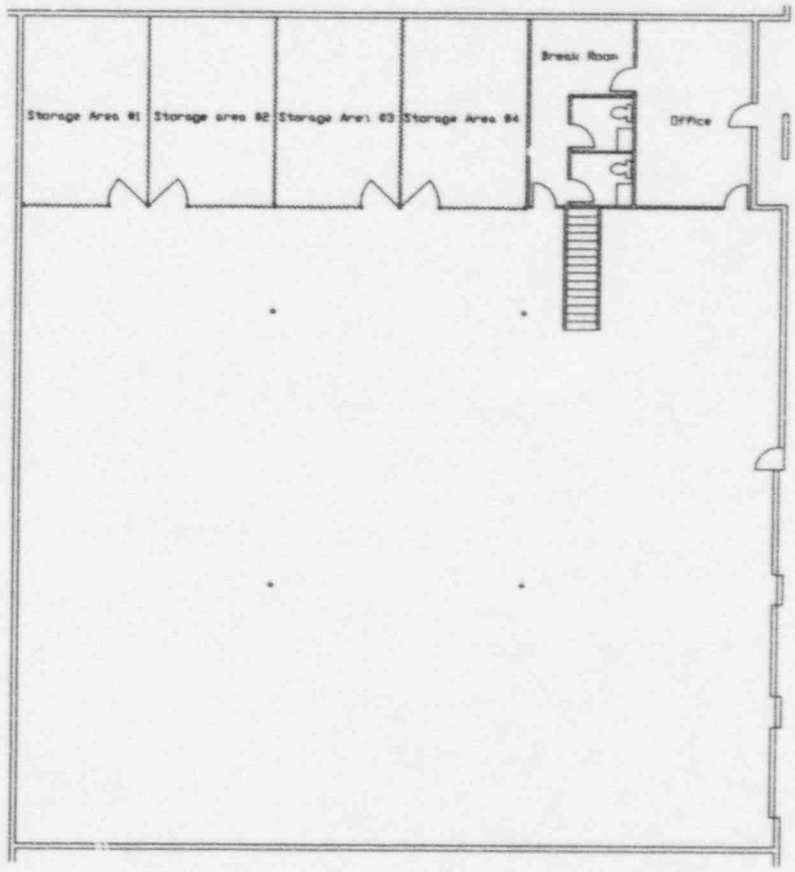
La PLAZA OFFICE COMPLEX–1st FLOOR

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
CHARACTERIZATION RESEARCH DIVISION
944 E. HARMON
LAS VEGAS, NV. 89119–6721

04/18/96
Drawn By:
F.L.Childers

Enclosure 16





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY NATIONAL EXPOSURE RESEARCH LABORATORY CHARACTERIZATION RESEARCH DIVISION LAS VEGAS, NEVADA	
DRAWING NAME	WAREHOUSE @ 3201 SUNRISE
DATE	SCALE
20 DEC 1995	

Enclosure 17

REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIAL ( ) NEW ( ) REVIEW ( ) AMENDMENT	DATE
THRU: Radiation Safety Officer TO: Radiation Safety Committee	FROM:
List Co-User(s): List Workers:	
Radionuclides and Maximum Activity of each which may be possessed at any one time (complete backside). ☐ Unsealed Source ☐ Sealed Source	
Areas of Radioactive Material Use	Storage Area:
Description of Use (Use additional sheets if needed)	
I ACKNOWLEDGE MY RESPONSIBILITIES AS PRINCIPAL USER. (Signature of Principal User)	ADMINISTRATIVE APPROVAL: (Signature of Chief of Department, Branch or Division)

RADIATION SAFETY COMMITTEE APPROVAL			
APPROVED: Radiation Safety Officer	APPROVED: Chairperson, Radiation Safety Committee	AUTHORIZATION NO DATE	REVIEW DATE

Enclosure 18

Page 2: REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIAL

Radionuclide	Total Activity Maximum amount	Maximum One Time Use Activity	Physical Form	Chemical Form

TRAINING AND EXPERIENCE OF RADIATION WORKER

1. Name (printed): _____

Date of Birth: _____ SSN: _____

Name of Authorized User: _____

2. Check "yes or no" in Columns I and II for the type of training you have had: if "YES", then complete Columns III and IV and Sections 3 and, if applicable, 4.

Field of Training	I Formal Course		II On-the-job Training		III Location and Dates (mo/yr) of Training	IV Number of hrs, days,etc
	yes	no	yes	no		
Principles and Practices of Rad Safety						
Biological Effects of Radiation						
Mathematics and calculations pertaining to the use and measurement of radioactivity						
Radiation instrumentation and monitoring procedures						
Radiopharmaceutical Chemistry, Radiation Biology, Nuclear/Radiation Physics						

3. Indicate the title and subject matter of each formal Course.

4. State your experience and use with materials; isotopes, the activities and the reason for usage, where the experience was obtained, and the duration of use.

Enclosure 19

RADIATION SAFETY EVALUATION FOR USE OF RADIOACTIVE MATERIAL

A radiation safety evaluation will be conducted by the Radiation Safety Officer prior to:

a. Approval of a new radioactive material authorization.
b. Review of an authorization.
c. A change in a current authorization such as isotopes, quantities, rooms, protocols, etc.

1. Authorized User _____ Division/Branch _____

2. Authorized Use Area(s): _____

a. Work Benches				
Absorbent paper	Y	N	NA	
Radioactive material labeling	Y	N	NA	
b. Waste Receptacles				
Solid waste	Y	N	NA	
Liquid waste	Y	N	NA	
c. Authorized Sink Disposal	Y	N	NA	Room_____
Disposal log	Y	N	NA	
d. Fume Hood Required	Y	N	NA	
Air flow check	Y	N	NA	
e. Signs				
Room entrance	Y	N	NA	
Storage Area	Y	N	NA	
Waste Area	Y	N	NA	
f. Shielding	Y	N	NA	

3. Personnel Safety Item Requirements:

a. Gloves	Y	N	NA
b. Lab coats	Y	N	NA
c. Shoe covers	Y	N	NA
d. Eye protection	Y	N	NA
e. Respirator	Y	N	NA
f. Other _____			

4. Instrumentation and Personnel Monitoring Requirements:

a. Dosimetry (TLD)	Y	N	NA
b. Bioassays	Y	N	NA
c. Room monitor	Y	N	NA
d. Air samples	Y	N	NA
e. Survey instrument	Y	N	NA
f. Radiation surveys	Y	N	NA
g. Contamination surveys	Y	N	NA

5. Additional Comments:

6. ALARA: Based on this evaluation, maximum individual exposures should not exceed _____ millirem per quarter. An investigational exposure limit of _____ millirem per quarter will be used by the Radiation Safety Officer to maintain exposures ALARA.

Evaluation conducted by _____ Date _____

Signature _____

Enclosure 20
(571951)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

Not included in tie-down, but goes to DCS with case.

OFFICE OF
RESEARCH AND DEVELOPMENT

October 18, 1996

US Nuclear Regulatory Commission, Region IV
Walnut Creek Field Office
Attention: Licensing and Materials Branch
1450 Maria Lane
Walnut Creek, California 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981
Mail Control No. 571951

Dear Sir:

Please reference the enclosure for our revised Statement of Intent for the decommissioning of our facilities. If you have any questions, please call me at (702) 798-2525.

Sincerely,

Wayne N Marchant

Wayne N. Marchant
Director, Characterization Research Division

Enclosure

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571951

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

OFFICE OF
RESEARCH AND DEVELOPMENT

OCT 17 ----

Financial Assurance for Decommissioning of Facilities under NRC License Number 27-05861-02

STATEMENT OF INTENT

The U.S. Environmental Protection Agency (EPA), National Exposure Research Laboratory (NERL), Characterization Research Division, Las Vegas (CRD-LV), hereby declares its intent to ensure that sufficient funding will be appropriated and available to decommission buildings described in NRC License Number 27-05861-02.

It is intended, subject to the availability of funds, that funding will be available sufficiently in advance of decommissioning to prevent the delay of required actions. Pursuant to 10 CFR 30.35, 40.36, and 70.25, the amount of funding required is $1.5 million. It is acknowledged that this amount is based on the radioactive materials and their maximum activities authorized under this NRC license, not upon the levels of radioactivity actually possessed or used at this facility.

All records for the purpose of decommissioning will be maintained at 944 E. Harmon, Chemistry building.

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
(702/798-2100 · FTS 545-2100)

MAY 8 1991

Financial Assurance for Decommissioning of
Facilities used under Byproduct Material License
Number 27-05861-02

Statement of Intent

The U.S. Environmental Protection Agency Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV) hereby declares its intent to assure that sufficient funding will be appropriated and available through the Environmental Protection Agency to decommission buildings described in Byproduct Material License Number 27-05861-02 (Expiration date: February 28, 1994).

It is intended, subject to the availability of funds, that funding will be available sufficiently in advance of decommissioning to prevent delay of required actions. Following the guidance provided in 10 CFR 30.35 (d), 10 CFR 40.36, and 10 CFR 70.25, the table of required amounts of financial assurance for decommissioning by quantity of material indicates $750,000. It is acknowledged that this amount is based on the maximum activity authorized under this license and is not related to the levels of activity actually possessed or used at this facility.

Furthermore, records important to decommissioning will be maintained in the Radiation Safety Office.

Authority:

Robert N. Snelling
Acting Director

Witness:

David G. Easterly
David G. Easterly, Chairman
Radiation Safety Committee

Bruce B. Dicey
Bruce B. Dicey
Radiation Safety Officer

571951

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

95 SEP 23 AM 11:16

September 19, 1996

OFFICE OF
RESEARCH AND DEVELOPMENT

U.S. Nuclear Regulatory Commission
Region IV
ATTN: Beth Prange
Sr. Health Physicist (Licensing)
Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

Dear Ms. Prange:

This is in response to your letter dated September 12, 1996 (refer to mail control number 57951, regarding exemption request, dated July 3, 1996), which requested submission of the reasons our exemption request should be continued.

The Office of Radiation and Indoor Air, Radiation Sciences Laboratory in Las Vegas (ORIA, RSL - LV) processes dosimeters predominantly associated with U.S. Department of Energy (DOE) activities. RSL - LV processes dosimeters for eight radiation workers (covered under NRC license), seven for the ORIA - LV and one for the National Exposure Research Laboratory in Las Vegas (NERL - LV); for forty-five occupational workers, eleven for NERL - LV and thirty-four for ORIA - LV. In addition, we act as a back-up to the Nevada Test Site (NTS) External Dosimetry Personnel Monitoring Program, which includes the Federal Radiological Monitoring and Assessment Center (FRMAC) and other radiological emergency response activities.

Providing external dosimetry for DOE in the areas around the NTS, including both environmental and personnel TLDs, requires Department of Energy Laboratory Accreditation Program (DOELAP) accreditation. The financial burden we would incur if required to apply for National Voluntary Laboratory Accreditation Program (NVLAP) accreditation and associated fees would be excessive, amounting to approximately $10,000.00 for the application plus personnel time.

Currently we are DOELAP accredited in categories I, II, IIIA, IV, and VII. The performance testing criteria for DOELAP exceed those of NVLAP for all categories except categories I and II, for which the criteria are the same. Specifically, for both NVLAP and DOELAP the tolerance level (L) is the same (L = 0.3) for categories I and II (that is, category I, accidents, low-energy photon, and category II, accidents, high-energy photons). But for categories IIIA, IV and VII (Mixture Categories III + IV) , the DOE criteria are more strict.

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57951

Specifically, L for NVLAP is 0.5, whereas for DOELAP it is 0.3. The more restrictive performance testing necessary to obtain DOELAP accreditation is preferable to maintain a higher standard of quality assurance and control. RSL - LV does not process dosimeters specifically for beta or neutrons.

In summary, our program would be best served from a financial and quality assurance point of view if we were to receive an exemption.

If you or other NRC staff have technical questions, we would be pleased to host a telephone conference call at which our staff would answer questions. This might facilitate your review of this request, and avoid the lost time associated with exchanging letters.

Enclosed is the copy of our DOE interagency agreement you requested. If you require further clarification in this matter, please do not hesitate to contact Anita Mullen at (702) 798-2597, or Christopher Fontana at (702) 798-2429.

Sincerely,

Wayne N Marchant

Wayne N. Marchant
Director
Characterization Research Division

Enclosure

wo/enclosure
cc: Loyd Carroll
Chrisitian Daughton
Anita Mullen
Paul Weeden

DE-AIO8-96NV11969
INTERAGENCY AGREEMENT (IA) BETWEEN
THE U.S. DEPARTMENT OF ENERGY
AND
THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FUNDS-OUT IA

This IA consists of the following:

IA Face Page

Article	I	Purpose
Article	II	Scope of Work
Article	III	Costs, Support Level, Budgeting, and Finance
Article	IV	Deliverables/Reports
Article	V	Duration of Agreement
Article	VI	Program Officers
Article	VII	Obligation of Funds
Article	VIII	Payment
Article	IX	Classification
Article	X	Property Fire Protection
Article	XI	Documents Attached and Part of this Agreement
Article	XII	Documents Incorporated by Reference

571951

I. PURPOSE

The purpose of this Agreement is to define respective responsibilities of the parties. This Agreement will be administered on behalf of the U.S. Department of Energy (DOE) by the Nevada Operations Office (DOE/NV), or any representative or representatives designated by the Contracting Officer (see Item 6 of Face Page). This Agreement will be administered on behalf of the U.S. Environmental Protection Agency by the Office of Radiation and Indoor Air (EPA/ORIA)(see Item 7 of Face Page). The EPA/ORIA provides radiological and non-radiological sampling and analytical capabilities required for compliance with DOE requirements, as well as Clean Air Act/National Emission Standards for Hazardous Air Pollutants (NESHAP, 40 CFR 61) and Clean Water Act (CWA, 40 CFR 161).

II. SCOPE OF WORK

a. General

This Agreement recognizes that both the EPA/ORIA and DOE have statutory responsibilities which are not limited or affected by this Agreement. This agreement covers those services EPA/ORIA will perform in connection with the DOE Stockpile Stewardship and Test Readiness Program and other DOE/NV activities, including providing assistance in DOE Nevada Test Site special projects, emergency preparedness (CONUS and OCONUS), and training. The scope of such services to be performed will be as requested by the DOE and within the limitation of the particular DOE program funds in fulfillment of DOE's statutory responsibilities and as agreed to by EPA/ORIA, within its capabilities and statutory limitations.

EPA/ORIA will provide radiological and non-radiological sampling capabilities for NTS and other facilities managed by DOE/NV. Sampling will consist of sampling stations at nearby cities and rural locations in accordance with appropriate DOE/NV guidelines, NESHAP (40 CFR 61), and CWA (40 CFR 161). Sampling will include, but not be limited to, the following: Air Particulates, Tritium-in-Air, Ground Water Monitoring, Milk, Pressurized Ion Chambers (PIC), Thermoluminescent Dosimetry (TLD). The EPA/ORIA is also to produce reports of the data available from previous historical sampling regimens as well as producing sampling report data for the DOE/NV Annual Site Environmental Report (ASER) each year. The EPA/ORIA will also provide similar data reports to support the NESHAP Annual Report. The EPA/ORIA will also provide "Down-Hole" sampling capabilities to the On-Site Radiological Environmental Monitoring Plan. The EPA/ORIA will provide emergency/accident sampling capabilities for DOE/NV as well as cross-check Quality Assurance and Quality Control programs as requested. The EPA/ORIA will act as the

backup dosimetry laboratory for the DOE prime contract dosimetry laboratory in emergency situations. The EPA/ORIA will also serve to provide environmental analytical/management services as requested by DOE/NV.

b. Radiological Environmental Monitoring Program

The EPA/ORIA will provide radiological environmental monitoring programs which include activities requested by DOE such as Stockpile Stewardship and Test Readiness Support, Special NTS Project Support, long term hydrological monitoring, dosimetry, and laboratory capabilities. EPA/ORIA will provide a panel member to the Experiment Controller. Programs will be staffed by qualified scientists and supporting personnel. Programs will be conducted in accordance with applicable federal regulations, DOE Orders, and industry standards.

c. Non-Radiological Monitoring

The EPA/ORIA will carry out public notification and will assist in evacuation programs as required by nonradiological effects of DOE/NV testing programs at any location. These programs will be with specific procedures mutually agreed upon by the EPA/ORIA, DOE/NV, and in consent with state officials. EPA/ORIA will provide a safety panel member to the Operations Controller at the Hazmat Spill Center (HSC) for project support. EPA/ORIA will provide nonradiological monitoring support at the HSC. Funding is provided by users utilizing the HSC and is separate from this agreement.

d. Quality Assurance Program

(1) The EPA/ORIA will develop, implement, and maintain a comprehensive Quality Assurance Program (QAP) and will comply with all applicable policies, regulations, requirements, and standards of the DOE as agreed appropriate by the DOE and EPA/ORIA, provided they do not conflict with EPA/ORIA regulations and statutory requirements. The EPA/ORIA's QAP will be structured in a manner to provide overall quality assurance (QA) policies and requirements for the work performed on the IA. The EPA/ORIA's overall QAP is auditable by the DOE/NV.

(2) For all work under this IA, the EPA/ORIA will include in all of its contracts, subcontracts, and consulting agreements, the substance of this QA provision, except for items and activities determined inappropriate by the EPA/ORIA.

e. Community Technical Representative Program

The EPA/ORIA will provide a comprehensive program designed to provide information and assistance to individual citizens, organizations, and local government agencies in communities near the NTS. The program will enhance communications with the public through hiring and training of local residents as Community Technical Representatives (CTR) or Alternate Community Technical Representatives (ACTR) and through developing and maintaining contacts and communications with community leaders and others. The EPA/ORIA will schedule, coordinate, and participate in public education forums as requested or required to maintain a viable program and assist in the ongoing training program for the CTRs and ACTRs. Data collection and analysis procedures will be provided, as well as interpretation and reporting of the data.

III. COSTS, BUDGETING, AND FINANCE

a. Costs

The total estimated cost for accomplishing the IA Statement of Work requirements for five years is as follows:

Direct and Indirect Costs	$15,000,000
Capital Equipment	-0-
Total	$15,000,000

b. Support Level

EPA shall authorize a maximum of 62 full time equivalent positions (FTE's) in support of the DOE programs. However, due to budget constraints placed on DOE it is understood that all FTE's will not necessarily be funded.

c. Work Plan and Budget

The parties will agree annually as to the scope of work to be performed during the period covered by the Agreement and costs thereof and the amount agreed to will be set forth in a modification to this Agreement. EPA/ORIA will provide a management

plan with appropriate budget estimates in sufficient time to be incorporated in DOE/NV annual budget requests.

d. Cost Reporting

EPA/ORIA will submit to DOE/NV monthly reports of the costs incurred in the performance of the work hereunder, by COB on the fourth workday following the end of the reporting month. Such reports will indicate accrued costs incurred for each DOE Budget and Reporting Classification or other similar cost category. Both current month and fiscal year-to-date cumulative costs will be reported on forms supplied by DOE/NV. Since EPA/ORIA accounting is obligation-expenditure (as opposed to accrued cost) based, obligations for all payroll and related costs and for transactions of less than $10K each for obligations falling under other OMB Object Classifications are considered for this purpose to be costs incurred. Nonpayroll obligations greater than $10K are not to be reported as costs until the goods/services in question are actually received (this does not affect billings--see paragraph d. below). A listing of obligations thus deferred (uncosted obligations) will be attached to each monthly cost report. Allocations of overhead are also to be included in the monthly costs reported. These overhead costs will be allocated to each of the costs categories specified above.

e. Cost Reimbursement

EPA/ORIA will be reimbursed monthly for obligations incurred, as required by EPA/ORIA Headquarters policy. Reimbursements will be accomplished via the Department of Treasury On-line Payment and Collection System (OPAC). Differences (both increases and decreases) between obligations and related actual expenditures will be included in the monthly billing/collection process as they become known. Amounts billed will be segregated into two main categories, direct and indirect, with standard OMB Object Classifications reported within each.

f. Cost and Commitment Limitations

The tasks under this IA are funded from various DOE program resources. This makes it necessary to require cost and commitment limitations (ceilings) for each program resource. A "Cost and Commitment Limitations Schedule" will be included as part of each IA modification that obligates or deobligates funds. The individual "Current Cost and Commitment Ceiling" amounts identified in that schedule cannot be exceeded. The EPA/ORIA will monitor costs incurred and commitments for each individual program resource and notify the DOE/NV Contracting Officer and the Resources Management Division in writing whenever current ceiling amounts are projected to be exceeded or substantially underrun. DOE/NV will then either revise

the scope of work under the IA or adjust the various funding levels. Reimbursement of costs incurred will be limited to the "Current Cost and Commitment Ceiling" specifically identified in the IA.

IV. Deliverables/Reports

Participation in formal mid-year and year end budget/schedule briefings
Monthly Cost Reports
Annual Budget Estimate
Contribution to Annual Environmental Report
Contribution to NESHAP Annual Report
Interim Test Reports
Monthly Performance Measurement System Report
Monthly Project Tracking System Report
Such other reports as may be required from time to time

The performing agency will deliver three copies of all reports to the DOE/NV Program Officer at the address shown, see Block 6, Face Page.

V. Duration of Agreement

See Block 4, Face Page.

VI. Program Officers

DOE and performing agency--see Blocks 6 and 7, Face Page.

VII. Obligation of Funds

The total amount presently obligated by the DOE/NV is $522,163.

No other agency has obligated funds under this Agreement.

VIII. Payment

Reimbursement will be accomplished via the Department of Treasury On-Line Payment and Collection System (OPAC). Monthly cost reports will include the following information:

A. DOE Accounting Appropriation Data, see Block 5(a), Face Page.

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21, P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $522,163. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

APPENDIX A
STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT
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APPENDIX A

STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT

1. Definitions. For purposes of this Agreement, "DOE" means the United States Department of Energy or any duly authorized representative thereof, and "Agency" means the performing agency stated in the Agreement of any duly authorized representative thereof.

2. Cost Chargeable to DOE Funds. Direct costs are the costs that can be directly identified with and charged to the work under the Agreement and within the limitations set forth below. Examples of such costs are salaries, technical services, materials, travel and transportation, communications, and any facilities and equipment expressly approved for purchase under the Interagency Agreement.

   a. Foreign travel costs are allowable only when approved by DOE.

   b. Reimbursement for expenditures at technical meetings and seminars at which attendance is not required by DOE, will not be allowable without prior written approval of the DOE Contracting Officer.

3. Financing. DOE will finance programs on a reimbursable basis when acceptable to the other agency. If the reimbursable basis is not acceptable, however, then DOE will finance the work by a Consolidated Working Fund Advance, preferably on a quarterly basis, or by an appropriation transfer or transfer appropriation. DOE will reimburse or will make available, in advance, the amount specified in the Interagency Agreement incorporating these general provisions. Requests for funds will show separately the amount required for (a) operating costs, (b) capital equipment (as defined in 9 below), (c) acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

   a. Vouchers for payment will be submitted on the agreed upon form.

   b. Any funds advanced which are expected to remain beyond the original period of performance for a program/project which is incomplete, of for which there is an increased scope of work, will remain available to the Agency if the IA is amended by the DOE to extend the period of performance for the research program/project or any other work beyond the original completion date. Request for such time extensions should be made to the DOE by the Agency at least 30 calendar days prior to the end of the performance period.

c. Any advanced funds remaining for a continuing research project or any other work remain available for the entire performance period of the project, unless there is a date specified as a required completion date after which no further funds will be expended.

d. Any advanced funds remaining after the completion of a research program/project will be reimbursed to the DOE.

4. Notice of Costs Approaching Total Estimated Costs. Whenever the Agency has reason to believe that the total cost of the work under this Agreement will be substantially greater or less than the presently estimated cost of the work, the Agency will promptly notify the DOE in writing. The Agency will also notify the DOE, in writing, when the aggregate of costs incurred and outstanding commitments allowable under this Agreement is equal to 90 percent (or such other percentage as the DOE may from time to time establish by notice to the Agency) of the presently estimated total costs under this Agreement. When the costs incurred and outstanding commitments equal 100 percent of such estimated total costs, the Agency will make no further commitments or expenditures (except to meet existing commitments) and will be excused from further performance of the work unless and until the DOE will increase the total estimated costs to be incurred with respect to this Agreement.

5. Excess Funds. The Agency will take prompt action to return to the DOE any funds determined to be excess to the work during the performance of the work and any unobligated funds after the completion of the Agreement or as of September 30 each year unless the Agreement has been extended and any unused balances have been carried forward in the extension. In a joint venture project where the performing Agency deposits the advance in any annual consolidated working fund, any unobligated balances will be returned to the DOE before the cutoff date at the close of each fiscal year.

6. Financial Reports. The Agency will furnish the DOE, not later than four working days after the close of each reporting period, monthly or other periodic cost or financial reports in such form and details as may be required by the DOE. Any costs incurred for capital equipment or other assets will be supported by a list showing the description, make, any serial number, and the cost of each item acquired.

7. Accounting Records. The Agency will accumulate and account for obligations and costs incurred in connection with the work being performed under this Agreement in such form and detail as may be required by the DOE.

8. Termination. Either party may terminate this Agreement upon 30 calendar days written notice of such termination addressed to the other party. In the event of such termination, the Agency will be reimbursed, to the extent permitted, for obligations actually incurred to the effective date of termination and for commitments extending beyond the effective date of

termination to a date not later than the date upon which the Agreement would have expired if not terminated under this paragraph, which the Agency, in the exercise of due diligence, is unable to cancel. Payments under this Agreement, including payments under this article, will not exceed the ceiling amount elsewhere specified in the Agreement.

9. Capital Equipment

   a. "Capital Equipment" means each item of equipment which is expected to have an extended period of service, generally two years or more, and has sufficient monetary value, generally of $5,000 or more, to justify continuing accounting records for the item.

   b. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the procurement or fabrication of capital equipment.

   c. If capital equipment is purchased or otherwise acquired pursuant to an authorization under Paragraph (b) above, except as may be otherwise agreed by the DOE and the Agency:

      (1) the title thereto will vest in the DOE;

      (2) the Agency will be responsible for the maintenance and safeguarding thereof; and

      (3) the Agency will maintain a record in such a manner as to ensure adequate control and accounting satisfactory to the DOE, of capital equipment procured or fabricated.

10. Real Property and Facilities

   a. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

   b. If the Agency acquires or condemns any real property or any facility or acquires, constructs, or expands any plant or facility pursuant to an authorization under (a) above, except as may be otherwise agreed by the DOE and the Agency:

      (1) the title thereto will vest in the DOE, and property accountability and control will become the responsibility of DOE;

      (2) the Agency will be responsible for the maintenance and safeguarding thereof; and

(3) the Agency will maintain a record thereof in such a manner as to ensure adequate control and accounting satisfactory to the DOE.

11. Patents. It is understood and agreed by DOE and the Agency that the patent policy to be employed in any particular undertaking under this Agreement between the parties, which includes research, development, or demonstration work and is supported by DOE funding, will be set forth in Appendix B.

12. Security of Restricted Data

a. Contracting Agency's duty to safeguard Restricted Data, Formerly Restricted Data, and other classified information. The Agency will, in accordance with DOE security regulations and requirements, be responsible for safeguarding Restricted Data, Formerly Restricted Data, and other classified information and protecting against sabotage, espionage, loss and theft, the classified documents and material in the Agency's possession in connection with the performance of work under this Agreement. Except as otherwise expressly provided in the Agreement, the Agency will upon completion or termination of this Agreement, transmit to DOE any classified matter in the possession of the Agency or any person under the Agency's control in connection with performance of this Agreement. If retention by the Agency of any classified matter is required after the completion or termination of the Agreement and such retention is approved by the DOE, the Agency will complete a certificate of possession to be furnished to DOE specifying the classified matter to be retained. The certification will identify the items and types or categories of matter retained, the conditions governing the retention of the matter and the period of retention, if known. If the retention is approved by the DOE, the security provisions of the Agreement will continue to be applicable to the matter retained.

b. Regulations. The EPA/ORIA will furnish to the DOE/NV Safeguards and Security Division copies of its periodic inspection reports or periodic memoranda covering the DOE/NV classified interest, citing that a satisfactory survey was conducted.

c. Definition of Restricted Data. The term "Restricted Data," as used in this clause, means all data concerning: (1) design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but will not include data declassified or removed from the restricted data category pursuant to Section 142 of the Atomic Energy Act of 1954.

d. Definition of Formerly Restricted Data. The term "Formerly Restricted Data," as used in this clause, means all data removed from the Restricted Data category under Section 142d of the Atomic Energy Act of 1954, as amended.

e. Security Clearance of Personnel. The Agency will not permit any individual to have access to Restricted Data, Formerly Restricted Data, or other classified information, except in accordance with the Atomic Energy Act of 1954, as amended, and the DOE's regulations or requirements applicable to the particular type or category of classified information to which access is required.

f. Criminal Liability. It is understood that disclosures of Restricted Data, Formerly Restricted Data, or other classified information relating to the work or services ordered hereunder to any person not entitled to receive it, or failure to safeguard any Restricted Data, Formerly Restricted Data, or any other classified matter they control in connection with work under this Agreement, may subject any representatives of the Agency, its agents, employees, or subcontractors to criminal liability under the laws of the United States. (See the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.; 18 U.S.C. 793 and 794; and Executive Order 12356.)

g. Contracts and Purchase Orders. Except as otherwise authorized in writing by DOE, the Agency will insert provisions similar to the foregoing in all applicable contracts and purchase orders under this Agreement.

h. Security Requirements for Proprietary Energy Data. The Agency will safeguard DOE official use information, or other proprietary or sensitive data (including material relating to patents), from unauthorized access, disclosure, modification, or destruction in accordance with applicable DOE security regulations and applicable orders and directives.

I. Computer Security Requirements. In the event this Agreement involves utilization of a DOE computer system, the Agency will establish administrative, technical, and physical security procedures in accordance with applicable DOE regulations, to ensure against access to DOE information to individuals not formally authorized by the DOE to possess such information.

13. Classification. The classification function under this IA will be performed by the Agency in accordance with applicable DOE regulations, orders, directives, and guidance.

a. All documents and material originated or generated by the Agency concerning potentially classified subject areas will receive appropriate classification review by the Agency. Classification determinations will be based upon classification guidance furnished by the DOE.

b. Every contract, subcontract, and purchase order issued hereunder involving the origination or generation of classified documents or material, will include a provision to

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21, P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $97,233. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

18. Transition From Former Agreement.

a. Agreement No. DE-AIO8-96NV11969 effective September 1, 1996, supersedes Agreement No.DE-AI08-91NV10963.

b. On and after September 1, 1996, all rights and obligations of the parties with respect to work described herein will be governed by the provisions of Agreement No. DE-AIO8-96NV11969.

c. The rights and obligations of the parties which have been incurred or which have accrued or matured under the provisions of Agreement No. DE-AI08-91NV10963 on or prior to September 1, 1996, will in nowise be impaired, limited, enlarged, or affected by reason of the provisions of this Agreement.

d. All materials, tools, machinery, equipment, supplies, and other property; all drawings, designs, specifications, and other engineering, technical, scientific, operating data, and records furnished to or acquired or generated by the Agency in connection with work under Agreement No. DE-AI08-91NV10963, to the extent that they are in the custody or possession of the Agency on the effective date of this Agreement, will remain in the custody or possession of the Agency for use in connection with the work under this Agreement, unless otherwise directed by the Contracting Officer.

e. All purchase orders, subcontracts, leases, licenses, permits, and other contractual commitments with third parties entered into pursuant to Agreement No. DE-AI08-91NV10963, and outstanding on September 1, 1996, will continue in effect for use in connection with the work to be performed under this Agreement unless otherwise directed by the Contracting Officer, and the reimbursement of costs incurred thereunder after September 1, 1996, will be subject to the provisions of this Agreement.

f. Subject to the foregoing paragraphs, all of the rights and obligations of the parties under Agreement No.DE-AI08-91NV10963, are assigned and transferred from said Agreement No. DE-AI08-91NV10963 to this Agreement No. DE-AIO8-96NV11969 and made a part hereof by this reference as though full set out herein. Subject to the other provisions of this Agreement, any costs associated with the transition from Agreement No. DE-AI08-91NV10963 to Agreement No. DE-AIO8-96NV11969 will be allowable cost.

APPENDIX B

INTELLECTUAL PROPERTY

Patents.

It is understood and agreed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (Agency) that the Intellectual Property Rights policy to be employed in any particular cooperative undertaking between the parties pursuant to this Interagency Agreement (IA) which is supported in whole or in part by DOE/NV funding will be as set forth below:

(a) In any contract, subcontract, or task order under a contract where the Agency has research, development, or demonstration (R,D&D) work performed by a contractor (other than a small business firm or nonprofit organization) and the work is not severable from that funded by the Agency, the Agency will incorporate the Patent Rights clause of 48 C.F.R. Section 952.227-13, dated March 1995. Where, however, the contract, subcontract, or task order is with a small business firm or nonprofit organization, the Patent Rights clause used in the contract will be in accordance with the provisions of P.L. 96-517. Patent Rights clause at 48 C.F.R. 952.227-11, dated March 1995, will be incorporated in the latter contracts.

(b) Offerors and prospective contractors (other than small business firms or nonprofit organizations) shall be provided with notice of and the opportunity to request at any time prior to the effective date of the contract or within 30 days thereafter, an advance waiver of all or any part of the rights of the United States with respect to inventions which may be conceived or first actually reduced to practice in the course of or under a cost shared contract. The clause at 48 C.F.R. 952.227-84, dated April 1984, may be used for this purpose. The Agency Contracting Officer will promptly forward such requests to DOE's Assistant General Counsel for Patents and will notify the contractor whether such request is granted in whole or in part.

(c) When the Agency has the work performed by Agency contractors, subcontractors, or consultants via contracts or subcontracts under this IA, funded in whole or in part by DOE, the contract or subcontract will incorporate, as the Intellectual Property Rights provisions, the DOE Patent and Data Supplement to Part II--Contract Clauses DOE Set 304, dated December 22, 1995, clauses 50 through 57, for cost-reimbursement service contracts and DOE Set 301S, dated December 22, 1995, clauses 46 through 54, for fixed price service contracts. Copies of these clause sets may be accessed via the Internet through the DOE Home Page and will be made available, upon request, from the DOE/NV Contracting Officer.

(d) Where an Agency contractor, subcontractor, or consultant will not accept the Intellectual Property Rights provisions provided by DOE, the Agency will not proceed with the

contract or subcontract without written approval of the DOE Patent Counsel.

(e) When the Agency has the work performed by Agency personnel, any inventions or discoveries made or conceived in the course of or in connection with such work will be reported and processed in accordance with the standard Agency procedure. However, the Agency will also report all such inventions to the DOE/NV and obtain DOE/NV's concurrence prior to making any determination in which the Government would retain less than the entire right, title, and interest to any such invention made by an Agency employee.

(f) DOE will have unlimited rights, as that term is defined in FAR 52.227-14, to any technical data generated during the performance of work under this IA. However, it is recognized that during the course of the work, the Agency or its employees, consultants, or contractors may from time to time desire to publish, within the limits of security requirements, information regarding scientific or technical developments made or conceived in the course of or under this IA. In order that public disclosures of such information will not adversely affect the Intellectual Property interests of DOE or the Agency, patent clearances and requests to establish copyright will be secured from DOE prior to any such release or publication. Otherwise, all generated technical reports and/or other engineering materials prepared under this IA will be freely exchanged and made available to the DOE/NV Contracting Officer for release to the public unless classified or restricted.

PART II
Contract Clauses

DOE List 304 – Cost Reimbursement Service Contracts

1.	FAR	52.252-2	Clauses Incorporated by Reference (JUN 1988) This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available.
2.	FAR DEAR	52.201-1 (OCT 1995) 952.202-1 (APR 1994)	Definitions
3.	FAR	52.203-3	Gratuities (APR 1984)
4.	FAR	52.203-5	Covenant Against Contingent Fees (APR 1984)
5.	FAR	52.203-6	Restrictions on Subcontractor Sales to the Government (OCT 1995)
6.	FAR	52.203-7	Anti-Kickback Procedures (JUL 1995)
7.	FAR	52.203-9	Requirement for Certificate of Procurement Integrity-Modification (SEP 1995)
8.	FAR	52.203-10	Price or Fee Adjustment for Illegal or Improper Activity (SEP 1990)
9.	FAR	52.203-12	Limitation on Payments to Influence Certain Federal Transactions (JAN 1990) *Applicable only if the contract estimated cost, including fee, exceeds $100,000.*
10.	FAR	52.204-4	Printing/Copying Double-Sided on Recycled Paper (MAY 1995)
11.	DEAR	952.208-70	Printing (APR 1984)
12.	FAR	52.209-6	Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (JUL 1995)
13.	DEAR	952.212-72	Uniform Reporting System (MAY 1987)
14.	FAR	52.215-2	Audit and Records-Negotiation (OCT 1995), Alternate II (OCT 1995) *Alternate II applies if the contract is with an educational institution.*
15.	FAR	52.215-22	Price Reduction for Defective Cost or Pricing Data (OCT 1995)
16.	FAR	52.215-23	Price Reduction for Defective Cost or Pricing Data-Modifications (OCT 1995)
17.	FAR	52.215-24	Subcontractor Cost or Pricing Data (OCT 1995)
18.	FAR	52.215-25	Subcontractor Cost or Pricing Data-Modifications (OCT 1995)
19.	FAR	52.215-26	Integrity of Unit Prices (OCT 1995), Alternate I (APR 1991). *Alternate I applies if the contract is not the result of full and open competition.*

20.	FAR	52.215-27	Ter[illegible]n of Defined Benefit Pension Plans (MAR 1996)
21.	FAR	52.215-30	Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
22.	FAR	52.215-31	Waiver of Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
23.	FAR	52.215-33	Order of Precedence (JAN 1986)
24.	FAR	52.215-40	Notification of Ownership Changes (FEB 1995) *This clause applies if certified cost or pricing data have been submitted or if any preaward or postaward cost determination is subject to FAR subpart 31.2.*
25.	FAR	52.215-42	Requirements for Cost or Pricing Data or Information Other Than Cost or Pricing Data-Modifications (OCT 1995), Alternate IV (OCT 1995)
26.	DEAR	952.216-7	Allowable Cost and Payment (DEC 1991), Alternates I AND II
27.	FAR	52.216-8	Fixed Fee (APR 1984) *This clause applies to this contract only if the contract makes provision for the payment of a fixed fee.*
28.	FAR	52.216-11	Cost Contract-No Fee (APR 1984) *This clause applies to this contract only if the contract makes no provision for the payment of a fee.*
29.	DEAR	952.217-70	Acquisition of Real Property (APR 1984)
30.	FAR	52.219-8	Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns (OCT 1995)
31.	FAR	52.219-9	Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (OCT 1995)
32.	FAR	52.219-16	Liquidated Damages-Subcontracting Plan (OCT 1995)
33.	FAR	52.222-1	Notice to the Government of Labor Disputes (APR 1984)
34.	FAR	52.222-2	Payment for Overtime Premiums (JUL 1990)
35.	FAR	52.222-3	Convict Labor (APR 1984)
36.	FAR	52.222-4	Contract Work Hours and Safety Standards Act-Overtime Compensation (JUL 1995) *Applicable to contracts which involve the employment of laborers or mechanics.*
37.	FAR	52.222-26	Equal Opportunity (APR 1984)
38.	FAR	52.222-28	Equal Opportunity Preaward Clearance of Subcontracts (APR 1984) *This clause applies to this contract only if the estimated cost, together with any fee, is $1,000,000 or more.*
39.	FAR	52.222-35	Affirmative Action for Special Disabled and Vietnam Era Veterans (APR 1984)
40.	FAR	52.222-36	Affirmative Action for Handicapped Workers (APR 1984)

41. FAR 52.222-37 Employment Reports on Special Disabled Veterans and Veterans of the Vietnam Era (JAN 1988)

42. FAR 52.222-41 Service Contract Act of 1965, as amended (MAY 1989)
Applicable if the principal purpose of the contract is to furnish services through the use of service employees as defined under Department of Labor regulations at Title 29, Code of Federal Regulations, Part 4.

43. FAR 52.222-42 Statement of Equivalent Rates for Federal Hires (MAY 1989)
Applicable if the clause at FAR 52.222-41, Service Contract Act of 1965 is applicable.

44. FAR 52.223-2 Clean Air and Water (APR 1984)
This clause applies to this contract only if the price is (a) in excess of $100,000; (b) a facility to be used has been the subject of a conviction under the applicable portion of the Air Act (42 U.S.C. 7413(c)(1)) on the Water Act (33 U.S.C. 1319(c)) and is listed by EPA as a violating facility; or (c) the acquisition is not exempt under FAR 23.104.

45. FAR 52.223-6 Drug-Free Workplace (JUL 1990)

46. FAR 52.223-14 Toxic Chemical Release Reporting (OCT 1995)

47. DEAR 952.224-70 Paperwork Reduction Act (APR 1984)

48. FAR 52.225-11 Restrictions on Certain Foreign Purchases (MAY 1992)

49. FAR 52.225-19 European Union Sanction for Services (JAN 1996)

50. FAR 52.227-1 Authorization and Consent (JUL 1995)
This clause applies only if so indicated elsewhere in this contract.

51. FAR 52.227-2 Notice and Assistance Regarding Patent and Copyright Infringement (APR 1984)
This clause applies only if the amount of this contract exceeds the dollar amount set forth in 13.000 of the Federal Acquisition Regulation.

52. DEAR 952.227-9 Refund of Royalties (MAR 95)

53. DEAR 952.227-11 Patent Rights-Retention by Contractor (Short Form) (MAR 1995)
This clause applies only if the contractor is a domestic small business or domestic nonprofit organization at the time of award.

54. DEAR 952.227-13 Patent Rights-Acquisition by the Government (MAR 1995)
This clause applies unless the Contractor is a domestic small business or domestic nonprofit organization at the time of award.

55. FAR 52.227-14 Rights in Data-General with Alternates I and V (JUN 1987)
This clause applies unless FAR 52.227-17 has been specified elsewhere in the contract.

55. FAR 52.227-16 Additional Data Requirements (JUN 1987)
This clause does not apply to this contract if the contract is for the conduct of basic or applied research, as set out elsewhere in this contract, to be performed solely by a college or university, and the estimated cost is not in excess of $500,000.

56. FAR 52.227-17 Rights in Data-Special Works (JUN 1987)
This clause applies only if specified elsewhere in the contract

57. FAR 52.227-23 Rights to Proposal Data (Technical) (JUN 1987)

58. FAR 52.228-7 Insurance-Liability to Third Persons (MAR 1996)

59. FAR 52.232-17 Interest (JAN 1991)
This clause applies to this contract unless (1) the contractor is (a) a Federal Agency; (b) a State of local government or instrumentality; (c) a foreign government or instrumentality or (d) a nonprofit organization, and the contract makes no provisions for the payment of a profit or fee; or (2) the contract is one for paid advertisements pursuant to Subpart 5.5.

60. FAR 52.232-20 Limitation of Cost (APR 1984)
This clause applies to this contract if it is a fully-funded contract.

61. FAR 52.232-22 Limitation of Funds (APR 1984)
This clause applies to this contract if it is an incrementally-funded contract to which the final funding increment has not been allotted.

62. FAR 52.232-23 Assignment of Claims (JAN 1986)

63. FAR 52.232-25 Prompt Payment (SEP 1992)

64. FAR 52.232-28 Electronic Funds Transfer Payment Methods (APRIL 1989)

65. FAR 52.233-1 Disputes (OCT 1995), Alternate I (DEC 1991)

66. FAR 52.233-3 Protest after award (AUG 1989), and Alternate I (JUN 1985)

67. DEAR 952.235-70 Key Personnel (APR 1995)

68. FAR 52.242-1 Notice of Intent to Disallow Costs (APR 1984)

69. FAR 52.242-3 Penalties for Unallowable Costs (OCT 1995)
This clause applies if this contract is for an amount over $500,000.

70. FAR 52.242-13 Bankruptcy (JUL 1995)

71. FAR 52.242-15 Stop-Work Order-Alternate I (APR 1984)

72. FAR 52.243-2 Changes (Cost-Reimbursement) Alternates I and V (AUG 1987)
Alternate V applies if the purpose of the contract is research and development.

73. FAR 52.244-2 Subcontracts (Cost-Reimbursement and Letter Contracts) (MAR 1996)

74. FAR 52.244-5 Competition in Subcontracting (JAN 1996)

75. FAR 52.244-6 Subcontracts for Commercial Items and Commercial Components (OCT 1995)

76. DEAR 952.245-5 Government Property-Cost-Reimbursement, Time-and-Material, or Labor-Hour Contracts), Alternate I (JUL 1985)
Alternate I applies if the contract is for research at nonprofit institutions of higher education or other nonprofit organizations whose primary purpose is the conduct of scientific research as may be indicated in Section H of the contract.

78. FAR 52.246-5 Inspection of Services-Cost-Reimbursement (APR 1984)
This clause applies unless the contract is for research and development

79. FAR 52.246-8 Inspection of Research and Development (Cost-Reimbursement) Basic and Alternate I (APR 1984)

This clause applies if the contract is for the conduct of research and development. Alternate I applies if the contract is on a no fee basis.

80. FAR 52.246-25 Limitation of Liability-Services (APR 1984)

81. FAR 52.247-63 Preference for U.S.-Flag Air Carriers (APR 1984)

82. FAR 52.247-64 Preference for Privately Owned U.S.-Flag Commercial Vessels (JUL 1995)

83. DEAR 952.247-70 Foreign Travel (APR 1984)

84. FAR 52.249-5 Termination of the Government (Educational and Other Non-Profit Institutions) 8APR 1984)
This clause applies if the contract is for research and development work with an educational or nonprofit institution on a no-profit or no-fee basis.

85. FAR 52.249-6 Termination (Cost-Reimbursement) (MAY 1986)
This clause applies to this contract unless the contractor is an educational or nonprofit institution, and the contract makes no provision for the payment or a profit or fee.

86. FAR 52.249-14 Excusable Delays (APR 1984)

87. DEAR 952.251-70 Contractor Employee Travel Discounts (JUN 1995)

United States Environmental Protection Agency
Washington DC 20460

EPA

Interagency Agreement / Amendment

Part I - General Information

1. EPA / IAG Identification Number	4. Funding Location by Region
RW89937611-01-0	HQ
2. Other Agency ID Number	**5. Program Office Abbreviation**
DE-AI08-96NV11969	OAR/ORIA/RSL
3. Type of Action	
NEW PROJECT	

6. Name and Address of EPA Organization
ENVIRONMENTAL PROTECTION AGENCY
RADIATION SCIENCES LABORATORY
P.O. BOX 98517
LAS VEGAS, NV 89193-8517

7. Name and Address of Other Agency
ENERGY, DEPARTMENT OF
NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518

8. Project Title TO PROVIDE CONTINUED SUPPORT TO ENVIRONMENTAL RESTORATION & WEAPONS PROGRAMS

9. EPA Project Officer (Name, Address, Telephone Number)
WEEDEN, PAUL J., DIRECTOR
EPA/OAR/ORIA/RSL
P.O. BOX 98517
LAS VEGAS, NV 89193-8517
(702) 798-2301

10. Other Agency Project Officer (Name, Address, Telephone Number)
MONROE, LESLIE A., EPD
DOE/NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518
(702) 295-1744

11. Project Period
09/01/96 to 08/31/01

12. Budget Period
09/01/96 to 08/31/01

13. Scope of Work (Attach additional sheets, as needed)

SCOPE OF WORK ATTACHED

THE EPA GRANTS SPECIALIST FOR THIS IAG IS
FELICA A. TARVER, PHONE NO. 202-260-8277

14. Statutory Authority for Both Transfer of Funds and Project Activities
ECONOMY ACT OF 1932 AS AMENDED

15. Other Agency Type
FEDERAL AGENCY

FUNDS	PREVIOUS AMOUNT	AMOUNT THIS ACTION	AMENDED TOTAL
16. EPA Amount	0	0	
17. EPA In-Kind Amount	0	0	
18. Other Agency Amount	0	522,163	
19. Other Agency In-Kind Amount	0	0	
20. Total Project Cost	0	522,163	

21. Fiscal Information

Site Name	DCN	FY	Approp.	Budget Org.	Program Elem.	Object	Site/Project	Cost Org.	Obligation
		96	CR	33D0X01	RLU				522,163

Part II - Approved Budget

EPA IAG Identification Number: RW89937611-01-0

22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	350,000	350,000
(b) Fringe Benefits	0	0
(c) Travel	20,000	20,000
(d) Equipment	63,883	63,883
(e) Supplies	78,280	78,280
(f) Procurement / Assistance	10,000	10,000
(g) Construction	0	0
(h) Other	0	0
(i) Total Direct Charges	522,163	522,163
(j) Indirect Costs: Rate 0.00% Base $ _____	0	0
(k) Total: (EPA Share: 0.00%) (Other Agency Share 100.00%)	522,163	522,163

23. Is Equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? ☐ Yes ☒ No
(Identify all equipment costing $1000 or more.)

24. Are any of these funds being used on extramural agreements? (See Item 22f.) ☒ Yes ☐ No

Type of extramural agreement ☒ Grant ☐ Cooperative Agreement ☒ Procurement (Includes Small Purchase Order)

Contractor / Recipient Name (If known)	Total Extramural Amount under this Project	Percent Funded by EPA (If known)
VARIOUS	522,168	0.00

Part III - Funding Methods and Billing Instructions

25.

☐ Funds-Out Agreement (Note: EPA Agency Location Code (ALC) - 68010727)

☐ Disbursement Agreement

☐ Repayment Request for repayment of actual costs must be itemized on SF-1080 and submitted to the Financial Management Office, Cincinnati, OH 45268:
☐ Monthly ☐ Quarterly ☐ Upon Completion of Work

☐ Advance Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

☐ Allocation Transfer-Out Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Hdqtrs. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. ☒ Funds-In Agreement

☒ Reimbursement Agreement ☒ Repayment ☐ Advance

☐ Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Resp. Center No.
DE-AI08-96NV11969	33D
Other Agency's Billing Address *(include ALC or Station Symbol Number)* Department of Energy Nevada Operations Office ATTN: Financial Management Division, P.O. Box 98518 Las Vegas, NV 89193-8518	**Other Agency's Billing Instruction and Frequency** ON-LINE PAYMENT AND COLLECTION (OPAC) SY SYSTEM IS USED

Part IV - Acceptance Conditions

EPA IAG Identification Number: RW89937611-01-0

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-in actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address US Environmental Protection Agency Grants Operations Branch B Grants Administration Division 401 M Street, SW (3903F) Washington, DC 20460	30. Organization/Address U.S. ENVIRONMENTAL PROTECTION AGENCY RADIATION SCIENCES LABORATORY P.O. BOX 98517 LAS VEGAS, NV 89193-8517

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	E. RAMONA TROVATO, DIRECTOR, ORIA	

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	W. SCOTT McMORAN, CHIEF GOB B/GAD	

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	BRADLEY M. BOURN, CONTRACTING OFCR.	

DOELAP

United States Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems

Certificate of Accreditation

U.S. Environmental Protection Agency

is recognized for demonstrating compliance with DOE performance criteria for personnel dosimetry systems. Accreditation is granted for the dosimetry systems and radiation categories specified in the conditions of accreditation.

November 1, 1994

Effective date

Robert M Laesch

DOE Laboratory Accreditation Program Administrator

CONDITIONS OF DOELAP ACCREDITATION

U. S. Environmental Protection Agency

Environmental Monitoring Systems Laboratory - Las Vegas

Effective until November 1, 1996, the whole body personnel dosimetry systems described below, used at the Environmental Monitoring Systems Laboratory - Las Vegas (USEPA), are granted DOELAP accreditation:

Dosimeter Identification:

Panasonic UD-802AT TLD.

Reader System:

Panasonic Model UD-710A Automatic Reader

DOELAP Categories: Panasonic UD-802

- I. Low-Energy Photons, High Dose Levels
- II. High-Energy Photons, High Dose Levels
- IIIA. Low-Energy Photons, Filtered X-Rays
- IV. High-Energy Photons
- ~~VII~~. Mixture Categories:
  - III + IV

Accreditation is for these dosimeters and reader systems only and is contingent upon maintaining dosimetry practices that are consistent with the methodologies used during DOELAP performance testing and the onsite assessment. Re-accreditation of your dosimetry system will be necessary every two years as required by DOE 5480.15 and as discussed in the DOELAP Handbook (DOE/EH-0026).

571951

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

OFFICE OF
RESEARCH AND DEVELOPMENT

July 3, 1996

U.S. Nuclear Regulatory Commission-Region IV
Walnut Creek Field Office
Attention: Materials (Licensing) Branch, Beth A. Prange
1450 Maria Lane
Walnut Creek, CA 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981
Control No. 571951

Subject: Exemption to 10 CFR 20.202(c) (now 10 CFR 20.1501)

Dear Ms. Prange:

As you suggested in your letter dated May 28, 1996, and during our conference call yesterday, I am enclosing two copies of DOE/EH-0026 and DOE/EH-0027. Both are current and dated December 1986. In connection with our pending license renewal application, I request continuance of our exemption to 10 CFR 20.1501 for our in-house dosimetry services for our radiation workers.

If you need additional information, please call me at 702-798-2525, or our Radiation Safety Officer, Loyd Carroll, at 702-798-2313.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

2 Enclosures (2 ea)

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (40% Postconsumer)

571951

DOE/EH-0027

DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health

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DOE/EH-0027
Distribution Category: UC-41

DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health
Washington, D.C. 20545

FOREWORD

This standard is intended to be used in the Department of Energy Laboratory Accreditation Program (DOELAP) for personnel dosimetry systems. It is based on the American National Standards Institute's (ANSI) *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11-1983,[1] recommendations made to DOE in *Guidelines for the Calibration of Personnel Dosimeters*, Pacific Northwest Laboratory (PNL)-4515[2] and comments received during peer review by DOE and DOE contractor personnel. The recommendations contained in PNL-4515 were based on an evaluation of ANSI N13.11 conducted for the Office of Nuclear Safety, DOE, by PNL.[3] Parts of ANSI N13.11 that did not require modification were used essentially intact in this standard to maintain consistency with nationally recognized standards.

Modifications to this standard have resulted from several DOE/DOE contractor reviews and a pilot testing session. An initial peer review by selected DOE and DOE contractor representatives on technical content was conducted in 1983. A review by DOE field offices, program offices, and contractors was conducted in mid-1984. A pilot performance testing session sponsored by the Office of Nuclear Safety was conducted in early 1985 by the Radiological and Environmental Sciences Laboratory, Idaho Falls.[4] Results of the pilot test were reviewed in late 1985 by a DOE and DOE contractor committee.

The DOE Laboratory Accreditation Program provides a structured means for assuring the quality of personnel dosimetry performance. The program was initiated and developed by the DOE Office of Nuclear Safety (Environment, Safety and Health) to improve the quality of personnel dosimetry through (1) performance testing, (2) dosimetry and calibration intercomparisons, and (3) applied research.

Participation in the program is required of all DOE and DOE contractor dosimetry programs (DOE Order 5480 Series). Further information with respect to the requirements and administration of DOELAP program is provided in the "Handbook for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" and the "Quality Assurance Manual for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" (applicable to the Performance Test Laboratory only).

Edward J. Vallario, Acting Director
Radiological Controls Division
Office of Nuclear Safety
U.S. Department of Energy

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DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

1.1 Purpose

This standard defines a set of reference performance tests to help establish a uniform approach to personnel dosimetry. The purpose of the standard is to describe minimum levels of acceptable performance and to provide procedures for the performance testing of personnel dosimetry systems.

1.2 Scope

The standard applies only to personnel dosimetry systems used for determining whole-body dose equivalent for the permanent record. The standard is applicable for dosimetry performed for health protection under controlled and uncontrolled conditions (accident dosimetry). Tests for accident dosimetry are approximately represented by the high-dose categories. The performance testing includes categories for the determination of dose equivalent (or absorbed dose) due to ionizing radiation only.

The standard also applies for specific energy intervals. The approximate intervals are from 15 keV to 2 MeV for photons, above 0.3 MeV (average energy) for beta particles, and from 1 keV to 2 MeV for neutrons.

Performance studies for angular dependence (Section 3.3) and lower limit of detectability (Section 3.4) are required one time only for each dosimeter type submitted for evaluation.

NOTE: Performance tests for extremity dosimetry, thermal neutron dosimetry and high-energy neutron dosimetry are excluded from this scope. These categories are planned for inclusion in future revisions of this standard.

1.3 Use

Reference calibration points for personnel dosimetry systems, including energies, source specifications and standard irradiation geometries are defined in sections 2.2, 2.3, and 2.4. The performance criteria defined in section 3.1 shall be used to evaluate dosimeter performance at each reference energy.

Calibrations used for the evaluation of occupational doses or dose equivalents may differ from the reference calibrations. Where such differences exist, the dosimeter's response per unit of delivered dose (or dose equivalent) for the calibration applicable to the occupational environment shall be determined relative to a reference calibration point. Determinations of calibrations specific to occupational environments shall be documented.

A facility should not be required to comply with all portions of this standard if a technical basis for exemption from identified categories is demonstrated.

1.4 Review

The standard shall be reviewed and updated by the Department of Energy (DOE) when considered necessary. Technological advances in both beta and neutron personnel dosimetry practices may allow strengthening of the performance specifications. In addition, it may be desirable to broaden the scope of the standard.

1.5 Definitions

The definitions for many of the terms used in this standard are given below:

Absorbed Dose (D). The energy absorbed per unit mass at a specified point. The special unit is the rad. The SI unit is the gray (Gy). 1 Gy = 100 rad.

Accident Dosimetry. The determination of high levels of absorbed dose resulting from uncontrolled conditions.

Accreditation. The process of evaluating a program which uses personnel dosimeters to measure, report, and record dose equivalents received by radiation workers.

Angular Dependence. The response of a dosimeter as a function of angle of incidence of the radiation detected compared to its response at normal incidence (nonperpendicular incidence).

Applicant. A DOE or DOE laboratory contractor facility which has submitted an application for DOELAP accreditation and is participating in the accreditation process. The dosimetry processor may be the same as the applicant or may be under contract to the applicant to provide the processing service.

Bias (B). The average of the performance quotients, P_i for n dosimeters, for a specified irradiation category and depth,

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1)$$

Calibration Specific to Occupational Environment. The dosimeter calibration applicable only to a particular occupational environment. These calibrations are determined by comparing reference measurements to dosimeter response measurements. Both measurements are performed in the work place.

Detection Threshold. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the mean readout value of unirradiated dosimeters.

Dose Equivalent (H). The product of the absorbed dose (D), the quality factor (Q), and any other modifying factors. The special unit is the rem. When D is expressed in Gy, H is in Sieverts (Sv). 1 Sv = 100 rem.

Dosimeter. A combination of absorber(s) and radiation-sensitive element(s) that is used to provide a cumulative record of absorbed dose or dose equivalent received when worn by an individual.

Estimate of Uncertainty (E). The estimated fractional uncertainty of the delivered dose or dose equivalent. The value excludes uncertainties associated with the exposure-to-dose-equivalent conversion factors for photon irradiations, the flux-to-dose equivalent conversion factor for neutron irradiations and the photon component of the neutron irradiations. The testing laboratory calculates this value.

Exposure-to-Dose-Equivalent Conversion Factor for Photons (C_x). The numerical quantity that relates the exposure in air to the dose equivalent at a specified depth in a material of specified geometry and composition. The C_x factors change as a function of photon energy, material geometry (e.g., sphere, slab, or torso), and material composition (e.g., tissue-equivalent plastic, soft tissue ignoring trace elements, or soft tissue including trace elements).

Free-Field Dose Equivalent. The dose equivalent assigned for neutron irradiation as if it were performed in free space with no background due to air and room scattering and no source asymmetry.[5]

High-Dose Range. A performance test range outside the normal operating range. Tests for accident dosimetry capability are conducted within this range.

In-Phantom Dose Rate for Beta Sources. The absorbed dose rate at the specified depth inside a tissue-equivalent phantom. Phantom dimensions are assumed to be 30 cm x 30 cm x 5 cm (or greater). The tissue equivalency is for beta radiations.

Irradiation Category. Each type and energy (or mixture) of radiation for which performance criteria are given.

Lower Limit of Detectability. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the readout value at the detection threshold.

Performance Quotient (P_i). The fractional difference between the reported and delivered absorbed dose or dose equivalent for the i^{th} dosimeter,

$$P_i = \frac{[X_i\,(\text{reported}) - X_i\,(\text{delivered})]}{X_i\,(\text{delivered})} \qquad (2)$$

where D_d, H_s, or H_d can be inserted for X. Here d and s refer to the depth at which D or H is specified, d for deep and s for shallow. The shallow absorbed dose, D_s, is not used in the performance criteria.

Processor. A supplier of personnel dosimetry services. These services include:

- Furnishing dosimeters to the user
- Evaluating the dosimeter readings after their return, in terms of the shallow and deep dose equivalent or the deep absorbed dose as prescribed in this standard
- Recording the results
- Reporting the results to the user.

Protection Dosimetry. Routine measurements and the estimation of the dose equivalent for the purpose of determining and controlling the dose equivalent received by radiation workers.

Shallow and Deep Absorbed Dose (D_s and D_d) or Dose Equivalent (H_s and H_d). The absorbed dose or dose equivalent at the respective depths of 0.007 cm and 1.0 cm in a material of specified geometry and composition.

Standard Deviation (S). The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth,

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)_2}{n-1}\right]^{1/2} \qquad (3)$$

Test. A procedure with the following sequence:

- Applicant submits dosimeters from current stock to a testing laboratory over a period of several months. The number of dosimeters submitted is sufficient for the specified irradiations in a given test category.
- Testing laboratory personnel irradiate the dosimeters using the type(s) of radiation specified for the test category.
- Applicant evaluates the response of the returned dosimeters in terms of shallow and deep dose equivalent for tests of protection monitoring or in terms of deep absorbed dose for tests in high-dose categories.
- Applicant submits these data to the testing laboratory.
- Testing laboratory analyzes the submitted data.
- Testing laboratory reports the results of this analysis (also referred to as "the test results") to the applicant.

Testing Laboratory. A laboratory independent of the applicant's operation, authorized by DOE to carry out the procedures outlined in this standard.

The words *shall*, *should*, and *may* are used as follows in this standard: *shall* denotes a requirement; *should*, a recommendation; and *may*, a permissible practice.

2. TEST PROCEDURES

2.1 Administrative Procedures

The performance tests are administered by the testing laboratory. The administrative procedures are described below.

2.1.1 Information to be Supplied to the Testing Laboratory. The applicant for accreditation shall provide the following:

- The test categories desired with justification(s) for those categories not chosen
- A brief description of dosimeter design, construction, and processing
- An indication of whether the dosimeter is in current use or planned for future use
- Angular-response data required in Section 3.3 and lower limit of detectability data required in Section 3.4 or a plan indicating how these data will be obtained and furnished to the testing laboratory
- Documentation of field calibrations if different from reference sources. The differences between the procedure, calculation, and/or calibration used for reporting occupational exposures shall be provided prior to the test procedure or along with the reported data.

The applicant shall certify that the dosimeters submitted for each test are representative of those supplied routinely to its users.

2.1.2 Number of Test Dosimeters. The applicant shall submit to the testing laboratory either 15 or 30 dosimeters for irradiation in any given test category. Submittal of 30 dosimeters requires a special arrangement with the testing laboratory (see Section 3.1). The dosimeters shall be submitted to the testing laboratory in three shipments. Additional dosimeters shall be included with each dosimeter shipment to serve as shipment controls and replacement spares. Dosimeters may be voided in a test category because of problems caused by the testing laboratory, the applicant, or the processor. The minimum number of irradiated dosimeters required for analysis of a 15-dosimeter test is 13 and for a 30-dosimeter test is 26. If this requirement is not satisfied, statistical analysis of the results in that category shall be delayed until replacement dosimeters have been submitted to the testing laboratory, irradiated, and the results are reported by the applicant to the testing laboratory.

2.1.3 Test Schedule. Each test shall extend over a period ranging from 3 to 6 months. The test dosimeters required for each test category shall be submitted to the testing laboratory in at least three separate groups as the testing laboratory directs. Each group shall be returned by the testing laboratory to the applicant within approximately 1 month of the announced start date for irradiations. Dosimeters submitted late may be included in the following month's irradiations. The applicant shall report the evaluations to the testing laboratory within 45 days of receiving the dosimeters. If this requirement is not met, it may be necessary to void all dosimeter evaluations in the same test category.

2.1.4 Dissemination of Test Results. The testing laboratory shall report all test results to the applicant after the test is completed. An estimate of the uncertainty of the assigned values of the delivered dose equivalent (or absorbed dose) shall be included in the report. The applicant shall not be permitted to change or void the reported values after receiving the test results from the testing laboratory.

2.2 Radiation Sources

The specified irradiations represent the minimum necessary to ensure adequate performance for a multipurpose personnel dosimetry system. Most of the irradiation categories specified and the range of dose equivalents were taken from the American National Standards Institute report ANSI N13.11-1983.[1]

The specifications for the test irradiations closely follow those given in ANSI N13.11. Major differences are: 1) the exposure-to-dose-equivalent conversion factors for photons (C_x) are specified for the calibration geometry; 2) the specifications for the beta source calibrations are more complete; and 3) additional photon, beta, and neutron sources are included. A more comprehensive discussion is presented in Appendix A.

The response of the personnel dosimetry system shall be determined using the following sources:

1. A sealed ^{137}Cs gamma-ray source

   - The irradiation geometry must be adjusted to achieve a shallow depth C_x factor of 1.03 ± 0.05 rem/R.

2. X-ray machine(s) that produce continuous spectra using the U.S. National Bureau of Standards (NBS) techniques[6] and are capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV)

   - The operable voltage range is between 30 kV and 160 kV constant potential for the NBS techniques (Table 1). The half-value layer and homogeneity coefficient shall be adjusted to match NBS specifications according to the recommendations in ISO 4037.[7] The half-value layers shall agree to within 2% and the homogeneity coefficients within 4% of the NBS specifications.
   - An ^{241}Am source may be substituted for the 55-keV to 65-keV nearly monoenergetic beam at the discretion of the testing laboratory.
   - The k-fluorescence x-ray technique may be used to generate the nearly monoenergetic beams.[7-9]

3. A sealed $^{90}Sr/^{90}Y$ beta-particle source with 100-mg/cm^2 filtration (nominal) to remove the ^{90}Sr component. It shall meet the following specifications:

Table 1. Reference sources

Source	Energy
Low-Energy Photons	
NBS Filtered Techniques[a]	
M30 (LG)[b]	20 keV (average)
S60 (MFC)[b]	36 keV (average)
M150 (MFI)[b]	70 keV (average)
H150 (HFG)	120 keV (effective)
Monoenergetic[c]	15 to 20 keV
Monoenergetic[c]	55 to 65 keV
^{241}Am[c,d]	59 keV
High-Energy Photons	
^{137}Cs[b]	662 keV
Beta Particles	
^{204}Tl	0.76 MeV (maximum)
$^{90}Sr/^{90}Y$ (filtered)[b]	2.3 MeV (maximum)
Natural or Depleted Uranium[c]	2.3 MeV (maximum)
Neutrons	
^{252}Cf (moderated)[b,e]	
^{252}Cf (unmoderated)	

a. NBS Special Publication 250, Appendix C.[6] The half-value layer and homogeneity coefficient should be adjusted according to the recommendations in ISO 4037.[7]

b. These sources are also specified in ANSI N13.11-1983.[1]

c. These sources were included for specific occupational environments.

d. At the option of the testing laboratory, the ^{241}Am source may be substituted for the 55- to 65-keV monoenergetic source.

e. Moderated by 15 cm of D_2O.[11]

- The residual maximum energy, as defined in the International Standard ISO 6980,[10] shall equal or exceed 1.80 MeV.
- The in-phantom dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 1.01 ± 0.03.
- The in-phantom dose rate at 1000 mg/cm^2 shall be less than 1% of the dose rate at 7 mg/cm^2.
- The dosimetry and energy measurement specifications shall take precedence over irradiation geometry specifications.

4. A sealed ^{204}Tl beta-particle source meeting the following specifications:

   - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV.
   - The in-phantom dose rate at 20 mg/cm^2 divided by the in-phantom dose rate at 7 mg/cm^2 shall be 0.80 ± 0.05.
   - The dosimetry and energy measurement specifications shall take precedence over the irradiation geometry specifications.

5. A natural or depleted uranium slab meeting the following specifications:

   - The source protective covering shall be in the range between 3 mg/cm^2 and 7 mg/cm^2 inclusive.
   - The dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 0.58 ± 0.04.
   - The in-phantom dose rate at 1000 mg/cm^2 shall be less than 3% of the dose rate at 7 mg/cm^2.
   - The measurement specification shall take precedence over the geometry specification.
   - The dimensions of the source must exceed the dimensions of the irradiated dosimeters.

6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[11]

2.3 Radiation Field Calibrations

Procedures used for calibrating radiation fields shall reference them to source fields standardized by NBS and shall be consistent with accepted national standards and practices. Reference class instruments, as defined in NBS Special Publication 603,[12] or sealed radioactive sources shall be used. (A list of calibration services offered by NBS is included in NBS Special Publication 250.[6]) The testing laboratory shall participate in a Measurement Quality Assurance Program with NBS.

The list of reference sources is given in Table 1. The rationale for selecting the reference calibration sources is discussed in Section A.1 of Appendix A. Requirements for beta calibration spectra are discussed in Section A.2 of Appendix A.

2.3.1 Photon Fields. Photon radiation fields shall be calibrated in terms of exposure in free air. Reference class ionization chambers calibrated by NBS for the particular techniques specified in Table 1 shall be used for the NBS techniques and the ^{137}Cs source. Other photon sources shall be calibrated with a reference class ionization chamber with a measured slowly varying energy dependence which has been calibrated by NBS or intercompared with NBS calibrated chambers in the appropriate energy range.

The dose equivalent assigned to exposed dosimeters shall be calculated using the exposure-to-dose-equivalent conversion factors (C_x) listed in Table 2. (The rationale used for choosing this particular set of C_x factors is given in Appendix A, Section A.3.) Absorbed dose and dose equivalent for radioactive source irradiations shall be calculated:

$$H_s = QC_{x,s}\dot{X}_{air}t; \quad H_d = QC_{x,d}\dot{X}_{air}t; \quad D_d = C_{x,d}\dot{X}_{air}t \tag{4}$$

where $\dot{X}_{air}$ is the exposure rate in air calibrated using the above procedure, s refers to shallow, d refers to deep, t is the irradiation time and Q is the quality factor (1 Sv/Gy). The shallow dose equivalent rate for ^{137}Cs exposures shall be measured for each source and the irradiation geometry shall be adjusted to achieve a $C_{x,s}$ value of 1.03 ± 0.05 rem/R. The suggested method is with an extrapolation chamber embedded in a methylmethacrylate phantom.

For x-ray exposures referenced to an unsealed monitor ionization chamber,

$$H_s = QC_{x,s}TMC_{TP}; \quad H_d = QC_{x,d}TMC_{TP}; \quad D_d = C_{x,d}TMC_{TP} \tag{5}$$

Table 2. Exposure-to-dose-equivalent conversion factors for photons[a]

NBS Filtered X-ray Techniques	C_x Conversion Factors, rem/R[b]	
Technique	Shallow (0.007 cm)	Deep (1.0 cm)
M30	1.08	0.45
S60	1.15	1.07
M150	1.41	1.47
H150	1.41	1.41
K-Fluorescence X-ray Techniques		
Energy, keV		
16	1.08	0.38
24	1.07	0.74
34	1.07	0.99
43	1.28	1.30
58	1.47	1.54
78	1.61	1.72
100	1.59	1.74
^{137}Cs		
662	—[c]	1.03

a. Data taken from Yoder et al.[13]

b. The SI unit conversions are 1 rem = 10^{-2} Sv and 1 R = 2.58×10^{-4} C/kg.

c. This value is dependent on source geometry and shall be measured for each source. The irradiation geometry must be adjusted to achieve a value of 1.03 ± 0.05 rem/R.

where T is the exposure-per-charge calibration factor for the monitor chamber at the standard temperature and pressure; M is the reading of the monitor chamber in units of charge; and C_{TP} is the temperature and pressure correction factor for the monitor chamber.

2.3.2 Beta-Particle Fields. Beta-particle fields shall be calibrated in terms of absorbed dose at a tissue depth of 7 mg/cm^2 using a thin-window, tissue-equivalent extrapolation chamber with the appropriate thickness of tissue-equivalent material in front of the window. The extrapolation chamber shall be calibrated using a beta-particle source with a calibration referenced to standards maintained by NBS. A tissue-equivalent extrapolation chamber typically contains a shell, a collecting electrode, and a front window of tissue-equivalent plastic. If air is used in the volume, an appropriate correction factor (stopping power ratio) shall be required.

Calibration depths used for beta irradiations can range from a few tenths of milligrams per square centimeter to 7 mg/cm^2. If a source has been calibrated at depths other than 7 mg/cm^2, measurement of a transmission factor shall be performed. The transmission factor shall be measured with a thin-window ionization chamber or extrapolation chamber. The chamber shall be positioned with its effective center at the calibrated point. Measurements shall then be performed at the depth of calibration and at a depth of 7 mg/cm^2. If material must be added to reach the required measurement depth, it shall be placed in contact with the chamber window. The total material thickness should be within ± 0.5 mg/cm^2 of the nominal measurement depth or measurement data collected with greater

and lesser thicknesses shall be used to obtain the correct value by interpolation. The transmission factor shall be calculated as follows:

$$C_{trans} = \frac{\dot{X}(7\ mg/cm^2)}{\dot{X}(d)} \quad (6)$$

where $\dot{X}$ is the relative chamber signal, corrected for temperature and pressure, and d is the original calibration depth.

The dose equivalent assigned to exposed dosimeters shall be calculated using

$$H_s = \dot{D}_t(d) \cdot t \cdot Q \cdot C_{trans} \quad (7)$$

where $\dot{D}_t$, is the absorbed dose rate at the calibration depth d, t is the time, and Q is the quality factor (1 Sv/Gy).

2.3.3 Neutron Fields. The ^{252}Cf sources shall be calibrated in terms of neutron emission rate by NBS or another qualified laboratory using equipment and techniques referenced to NBS-maintained standards. Procedures for calculating the dose equivalent for exposed dosimeters shall follow NBS Special Publication 633.[5] In this publication the free-field dose equivalent (mrem) for unmoderated exposures is defined by:

$$H_d = \frac{N \cdot C_U \cdot t \cdot 3600}{4\pi r^2} \quad (8)$$

where N is the neutron emission rate (n/sec), C_U is the dose-equivalent conversion factor for unmoderated ^{252}Cf (3.33×10^{-5} mrem-cm^2/n), t is the time (h), 3600 is the number of seconds in an hour, and r is the calibration distance (from the source center to the front face of the phantom, cm). For the moderated source,

$$H_d = \frac{N \cdot C_M \cdot t \cdot 3600 \cdot 0.885}{4\pi r^2} \quad (9)$$

where C_M is the dose-equivalent conversion factor for moderated ^{252}Cf (9.08×10^{-6} mrem-cm^2/n), and the 0.885 factor allows for the loss of the number of neutrons moderated below the cadmium cutoff.[14]

NOTE: Ing and Cross[15] quote slightly different values for C_M because they use a lower limit of 1 eV for their calculations. The effect of the neutrons between the cadmium cutoff and 1 eV account for differences in C_M and the neutron loss fraction (see explanation in Schwartz, Eisenhauer and Grundl[16]).

The applicant can obtain direct calibration factor(s) from the testing laboratory. Otherwise, the applicant should consider applying correction factors to the dosimeter readings for air scattering, room return, and source scattering. These techniques are described in NBS Special Publication 633.[5]

The photon component for each irradiation source geometry shall be measured. Unmoderated ^{252}Cf irradiations probably have a greater variation of photon component than the moderated irradiations because of greater relative differences in source filtration. Typical values are 7% of the neutron dose equivalent for unmoderated irradiations[17] and 18% for moderated irradiations.[18]

2.4 Irradiation Geometries and Uncertainties

The dosimeters shall be irradiated using a phantom backing, except for on-contact slab-source exposures. The phantom shall be methylmethacrylate slabs measuring 30 cm x 30 cm x 15 cm for photon calibrations, 30 cm x 30 cm x 5 cm (or greater) for beta-particle calibrations, and 40 cm x 40 cm x 15 cm for neutron calibrations. The dosimeters shall be attached to the surface of the phantom facing the source (front face). For collimated beams, the central beam axis is positioned perpendicular to and passing through the center of the front face of the phantom. For uncollimated beams, the center of the front face of the phantom is positioned perpendicular to a radial line from the source center. Dosimeters shall be mounted with the sensitive elements within the central 15-cm x 15-cm area of the phantom for photon and beta-particle irradiations and within the central 20-cm x 20-cm area for neutron irradiations. The point of calibration shall coincide with the center of the front face of the phantom. The irradiation geometries summarized in Table 3 shall be used.

For photon and beta-particle irradiations, the scatter from the surfaces of the irradiation room and from the source and phantom support hardware shall contribute only a small fraction to the uncertainty in the assigned dose equivalent. If several dosimeters are irradiated simultaneously, precautions shall be taken to keep the mutual interference much smaller than the uncertainty in the assigned dose equivalent.

Table 3. Dosimeter irradiation geometries

Source Type	Phantom Size, cm	Distance, cm[a]	Maximum Useful Area[b]
Photon Sources	30 x 30 x 15		15 cm x 15 cm
^{137}Cs		≥ 100	
NBS filtered x-rays		≥ 100	
Monoenergetic x-rays		≥ 50	
Beta Sources			
$^{90}Sr/^{90}Y$	30 x 30 x ≥ 5	≥ 30	15 cm x 15 cm
^{204}Tl	30 x 30 x ≥ 5	30-50	15 cm x 15 cm
Slab Uranium	—	On contact	—
Neutron Sources	40 x 40 x 15	≥ 50	20 cm x 20 cm

a. Distance from the source center to the front face of the phantom.

b. Position dosimeters so that the sensitive elements fall within the useful area, centered on the front face of the phantom.

The uncertainty in the assigned dose equivalent shall not exceed ±5%, excluding uncertainties in the dose equivalent conversion factors and the photon component of the neutron irradiations. Dose-rate uniformity measurements shall be performed to determine the useful exposure area. Included in the 5% limit are uncertainties due to source standardization, the uncertainty due to dosimeter position, and the uncertainty due to scattered radiation not stemming from the phantom. The systematic and random uncertainties shall be summed quadratically and separately. The ±5% limit shall be imposed on the total linear sum of the systematic and random uncertainties. (Refer to Chapter 23 of NBS Handbook 91[19] for guidance on quoting uncertainties.)

NOTE: To achieve a total uncertainty not in excess of ±5%, it may be necessary to measure and use position-specific correction factors. This can reduce the contribution to the total uncertainty due to dose-rate nonuniformity to an acceptable level.

2.5 Irradiation Level Selection

In each category, the irradiation levels shall be chosen at random using the logarithms of the dose equivalents or absorbed doses. Random selection of the logarithms of the irradiation levels rather than the levels themselves increases the probability of selecting values near the lower limit of the range. Values for the 1-cm depth shall be used except for the beta-particle category or mixtures using beta sources, for which the shallow depth shall be used. In addition, for the categories dealing with mixed radiation fields, the component ratios shall be selected at random. In these categories, the assigned dose equivalent of the larger component shall not be greater than three times that of the smaller component. The test range for the mixture categories specified in Table 4 applies to the summed dose equivalent.

The method for selecting irradiation levels within any one test category and test irradiation range shall be to select random numbers, ρ, between 0 and 1 and to represent the logarithm of the dose equivalent, H, as

$$\log H = \log(H)_\ell + \rho[\log(H)_u - \log(H)_\ell], \qquad (10)$$

where $(H)_\ell$ and $(H)_u$ are the lower and upper limits, respectively, of the range of test irradiation levels in question. The logarithms of absorbed doses shall also be selected using the same method.

Table 4. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 4. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]		0.05-5 rem	Shallow,
III & V	One energy	0.2-5 rem	Deep
IV & V[a]	from each	0.2-5 rem	
III & VI[h]	category	0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 1.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 11).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

3. PERFORMANCE STANDARDS

3.1 Performance Criteria

Performance in a given category or subcategory (see Table 4) shall be considered adequate if, for the shallow and/or deep dose equivalents (or the deep absorbed dose)

$$|B| + S - |E| \leq L \tag{11}$$

where B and S designate, respectively, the bias and standard deviation of the performance quotient for the particular category or subcategory, E is the estimation of the fractional uncertainty in the delivered dose or dose equivalent rate, and L is the tolerance level. The values of L shall be the following:

$$L = 0.30 \text{ for Categories I through VI}$$
$$L = 0.40 \text{ for Category VII.} \tag{12}$$

A modified performance criterion in lieu of Equation (11) shall be acceptable for the ^{204}Tl tests. The ^{204}Tl source shall not be used for mixtures (Category VII). The modified criterion is:

$$|B| - |E| \leq 0.40 \ (^{204}Tl \text{ only}) \tag{13}$$

The performance criteria in Equations (11), (12) and (13) shall be used until two years after the effective date of the DOE Order.[20] At that time, Equation (12) shall be changed to: "L = 0.30 for all categories" and Equation (13) shall be deleted. The performance criteria for ^{204}Tl shall then be the same (including mixtures) as for the other test sources.

NOTE: The standard of performance is based on achievable standards consistent with the goals of health protection. The test criterion,

$$|B| + S \leq 0.30 \tag{14}$$

can be interpreted as providing approximately 70% confidence that a dosimeter response would be within 30% of a conventionally true value. However, for workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence that the annual reported dose equivalent would be within 30% of a conventionally true value. The relationship of this criterion to the recommendations of the National Council on Radiation Protection and Measurements, the International Commission on Radiation Units and Measurements and the International Commission on Radiological Protection are contained in Appendix B.

The estimation of uncertainty (E) was included in the test algorithm to decrease the probability of an inadequate test result being assigned to an adequate dosimetry system. The test applicant receives the benefit of the uncertainty in the delivered dose or dose equivalent.

The ability of a dosimetry system to meet the performance criteria is typically limited by the mixture categories, especially those mixed with the low energy photon category. The tolerance level for mixture categories was set to 0.40 from 0.30 for the first two-year testing period to allow for unexpected difficulties and provides time for adjustments to meet the more stringent criteria to be imposed later.

The test for the low-energy beta source (^{204}Tl) is not required to use Equation (11) for the initial two-year period because of the technological and practical limitations of current dosimeter designs. The ^{204}Tl test algorithm was chosen based on the low-energy beta performance reported by Roberson et al.[3]

The number of dosimeters submitted for a category may be doubled (from 15 to 30) if the fractional standard deviation for that category is greater than 0.15. Determining which categories qualify is the responsibility of the applicant, with concurrence by the testing laboratory (see Section 2.1.2). If the performance of a dosimetry system is found inadequate at the conclusion of a performance test and the estimated probability is greater than 5% that the inadequate result was due to statistical fluctuations in the testing procedure, it shall be so noted on the test results and the applicant should consider submitting 30 dosimeters to that category during the subsequent retest period.

NOTE: The statistical uncertainty of the test results increases with the standard deviation (see Appendix B). Table B.1 of Appendix B lists the (approximate) two standard deviation uncertainties of the test result as a function of the true dosimeter standard deviation and the number of dosimeters used. These values may be used to estimate the probability of an inadequate performance due to

the uncertainties in the test results. Doubling the number of test dosimeters will decrease the effects of the test uncertainties.

The performance test shall be split into three parts in a period not shorter than 3 months and not longer than 6 months (see Section 2.1.3).

NOTE: The standard deviation is composed of dosimeter variations present in a batch of dosimeters read sequentially and the long-term variability of the calibration-plus-readout process. A sampling of the long-term variability is accomplished by splitting the evaluation over a period of time.

3.2 Irradiation Categories

The evaluation of the personnel dosimetry system shall use the categories listed in Table 4. The applicants shall submit dosimeters for testing in the high-dose categories (I and II) corresponding to the similar protection categories (III and IV).

NOTE: The high-dose category corresponding to Category IIIB is Category I due to the difficulty of achieving high-dose levels with nearly monoenergetic sources.

The nearly monoenergetic low-energy photon sources (Category IIIB), the uranium slab source (Category VB), and the special beta point sources (Category VC) were included for application to specific occupational environments. These categories may be used in place of or in addition to Categories IIIA and VA, depending on the occupational environments included in the service. Dosimetry services for an occupational environment containing significant quantities of plutonium shall use Category IIIB. If the same service covers areas with general x-ray sources, Category IIIA shall also be used.

Dosimetry services covering occupational environments containing uranium sources and having an established beta calibration program using slab uranium may use Category VB in place of VA. If the dosimetry service also covers environments with general beta emitters, then testing in Category VA shall be performed.

Category VC shall be used by contractors requiring either a high-energy or low-energy beta source test only. The desired source shall be specified before initiation of the performance test. If both high- and low-energy sources are required, Category VA shall be used. If both low-energy photon categories (IIIA and IIIB) or if two of the beta categories (VA, VB, and/or VC) are required, the dosimetry system may use different algorithms corresponding to those used for the different occupational environments.

If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) and uses the same algorithms for both categories, then only 5 dosimeters shall be submitted for each corresponding mixture category involving those categories. The spectra for those mixture irradiations shall be selected at random from the combined category. If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) using different algorithms for each category, then 10 dosimeters shall be submitted for each mixture, 5 for each category. In such cases, the applicant shall submit results using both algorithms. The testing laboratory shall choose only the appropriate irradiation categories for the performance test for each algorithm.

NOTE: Category VC was included to accommodate special dosimetry environments. It is expected that the choice of Category VC will be accompanied by a justification. Field measurement data may be required.

The radiation source from Category IIIA and each mixture category involving IIIA shall be chosen for each of the three testing parts at random without replacement. The choice of sources from Category IIIB and each mixture category involving IIIB will alternate for each test part. For each of the Categories IIIA, IIIB, IV, VA, VB, and VC and the mixture categories not using neutrons, the category used for individual irradiated dosimeters shall not be identified to the applicant until after test results are reported to the applicants. In addition, the sources used for the low-energy photon irradiations and the Category VA beta particle irradiations shall not be divulged until the test results are reported.

An applicant participating in neutron tests shall specify which neutron source most appropriately represents the spectral composition of occupational neutron fields which the dosimetry program covers. If both sources are required to adequately represent these neutron fields, the performance testing shall include both sources. The applicant may identify in advance the dosimeters submitted for the neutron tests. When the dosimeters are

returned for evaluation, the participant shall be told which dosimeters were irradiated with neutrons and which source was used. The testing laboratory shall provide pretest calibration exposures for the neutron sources upon request. The testing laboratory shall also provide the ratio of readings from a 9-in.-diameter spherical rem meter and a 3-in.-diameter sphere covered with 10-mil-thick cadmium as a relative calibration for albedo dosimeters.[21]

NOTE: This standard directs the testing laboratory to provide the calibration factor for the neutron performance tests to the applicant. The bias should indicate the ability to calibrate the dosimetry system to an external source. The dosimeter response relative to the testing source(s) and the occupational environments must be documented (see Section 1.3).

3.3 Angular Dependence

For each dosimeter design submitted for testing and for each type of radiation in Categories III through VI for which performance is tested, a study of dosimeter performance when the incident radiation is nonperpendicular shall be carried out once. The study need not be a part of a test series or performed by the testing laboratory. At least two different radiation spectra shall be used in Category IIIA and IIIB; low and mid-range energies should be considered. Category VB is excluded from this requirement. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for Angular Dependence Study. Mount the dosimeters on the front face of the phantom specified for the performance tests. Give identical irradiations to at least two dosimeters of each kind. Vary the angle of incidence in two planes perpendicular to each other and to the plane of the dosimeter in the original test configuration. Vary the angle by rotating the phantom through the appropriate angle. To achieve rotations along the horizontal axis of the dosimeter, rotate the dosimeter 90° on the phantom and rotate the phantom along its vertical axis.

At least seven different angles of incidence from -85° to +85°, including 0° (perpendicular incidence), shall be used in each of the two planes. Values for the dose equivalent for each irradiation exposure should be approximately 500 mrem. For a given angle of incidence and type and energy of incident radiation, the results of the angular dependence study shall be expressed as the ratio of the applicant's dose equivalent interpretation to the actually administered dose equivalent obtained on the basis of perpendicular incidence.

3.4 Lower Limit of Detectability

For each dosimeter design submitted for testing and for at least one source in Categories III through VI for which performance is tested, a study to determine the lower limit of detectability shall be conducted once and reported to the testing laboratory. The study need not be part of a test series or performed by the testing laboratory. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for the Lower Limit of Detectability Study. At least 10 dosimeters for irradiation per category, plus 10 dosimeters for background evaluation, for each dosimeter design, shall be selected from the routine-processed pool of dosimeters for this study. The dosimeters shall be placed in an unshielded environment for a time sufficient to obtain an unirradiated background signal typical for routine processed dosimeters. At least ten dosimeters shall be irradiated for each category to a dose significantly greater (e.g., 500 mrem) than the estimated lower limit of detectability. Both the irradiated and unirradiated dosimeters shall be processed and evaluated. The following quantities shall be calculated:

$$H_o = \frac{1}{n} \sum_{i=1}^{n} X_{io} \tag{15}$$

$$S_o = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{io} - H_o)^2 \right]^{1/2} \tag{16}$$

$$H_1 = \frac{1}{n} \sum_{i=1}^{n} X_{i1} \tag{17}$$

$$S_1 = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{i1} - H_1)^2 \right]^{1/2} \tag{18}$$

where X_{io} = unirradiated dosimeter values and X_i = irradiated dosimeter values. The values H_o and H_1 are the mean evaluated dose equivalent values

for the unirradiated and irradiated dosimeters, respectively, and S_o and S_1 are the associated standard deviations. The dosimeter readings shall be processed through the dose algorithms without truncation or distortion (i.e., do not zero any readings). If a background is subtracted, negative values shall be retained for the calculation of S_o. The algorithms for the calculation of shallow and/or deep dose equivalent shall be used to calculate H_o and H_1, depending on the category test specifications. The lower limit of detection, L_D shall be calculated as follows:

$$L_D = 2\,[t_p S_o + (t_p S_1/H_1)^2\, H_o'] \,/\, [1 - (t_p S_1/H_1)^2] \qquad (19)$$

where t_p is the t distribution for n-1 degrees of freedom and a p value of 0.95 (see NBS Handbook 91[19]) and H_o' is the average of the unirradiated dosimeter values without subtracting a background signal.

Alternate Method. If the performance testing was completed within six months of this study, then the values of B and S may be used to calculate [1.75 x S/(1 + B)] which may be used in place of $t_p S_1/H_1$ in Equation (19) for each category. Only a set of unirradiated dosimeters would be required to determine L_D.

NOTE: Equation (19) is based on the desire to minimize both false negative and false positive results. All values below the detection threshold should be set to zero. For example, $t_p S_o$ for p = 0.95 is an estimate of the detection threshold allowing 5% false positive values. For the lower limit of detection false negative values are also minimized. For p = 0.95, the probability of no more than 5% false positive and false negative values provides a lower limit of detection of:

$$L_D = t_{p,o} S_o + t_{p,D} S_D \qquad (20)$$

where S_D is the standard deviation at the lower limit of detectability and $t_{p,o}$ and $t_{p,D}$ depend on the number of dosimeters used to estimate S_o and S_D, respectively.

Equation (20) is an estimate of the equation

$$L_D = K_p\, \sigma_o + K_p\, \sigma_D \qquad (21)$$

where σ_o and σ_D are the true standard deviations and K_p is the abscissa of the standard normal distribution below which the total relative area under the curve is P. The σ_D value is composed of the fluctuation of the background (σ_o) and the fluctuation inherent in the readout process. If σ_1/H_1 is the relative standard deviation at high doses, then

$$\sigma_D^2 \simeq \sigma_o^2 + \left(\frac{\sigma_1}{H_1}\right)^2 (L_D^2 + 2\, L_D H_o) \qquad (22)$$

and solving for L_D,

$$L_D = 2\left[K_p\sigma_o + \left(K_p \frac{\sigma_1}{H_1}\right)^2 H_o\right] \Big/ \left[1 - \left(K_p \frac{\sigma_1}{H_1}\right)^2\right] \qquad (23)$$

Using t_p for K_p and S for σ, Equation (19) is obtained. If $t_{p,o}$ is not equal to $t_{p,D}$, the formula for L_D is not exact, but should be a close approximation. Additional information can be found in an article by Currie.[22]

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APPENDIX A

CHOICE OF REFERENCE CALIBRATION SOURCES

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Comparisons of occupational exposures reported for various DOE sites are made more difficult by the absence of standard calibration techniques and the use of many dosimeter designs. The establishment of reference calibration techniques will help quantify the effects of differing dosimeter designs and differing occupational environments. The choice of reference sources was based on an intercomparison of dosimeter system performances for DOE laboratories[A-1] and the American National Standards Institute's *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11.[A-2] Eleven DOE laboratories participated in the intercomparison to better define present differences and help develop improved techniques.

The intercomparison of dosimetry system performances was also used to evaluate ANSI N13.11 for use by DOE facilities. It was found that: 1) the number of test categories was incomplete; 2) the performance criteria specified did not achieve the goal of the tests as well as other algorithms; 3) the beta-particle category was not sufficiently specified; and 4) the choice of the photon conversion factors was arbitrary. The choice of reference sources was made to be as consistent with ANSI N13.11 as was practical.

A.1 Calibration Categories

The filtered x-ray beams chosen for Table 1 (main text) are National Bureau of Standards (NBS) techniques.[A-3] The M30 (20-keV) and S60 (36-keV) techniques represent the photon energy region of maximum response for most dosimetry systems. They represent a conservative worst-case test for low-energy photons. The M150 (70-keV) and H150 (120-keV) techniques are included to extend the test energies above those influenced by the photoelectric effect. The response of dosimetry systems is similar to that of tissue from approximately 200 keV to 2 MeV because of the dominance of the Compton interaction. Tests at these energies are represented by the high-energy photon category. Nearly monoenergetic x-ray sources at 15 to 20 keV and 55 to 65 keV and the ^{241}Am (59-keV) source were included specifically for facilities using plutonium.

Adequate performance for the ^{90}Sr/^{90}Y beta source does not imply adequate performance for all beta-particle energies. The ^{90}Sr/^{90}Y beta particles are sufficiently energetic to penetrate the popular, thick (235-mg/cm^2) LiF thermoluminescent (TL) dosimeter chip. This penetration results in a response for ^{90}Sr/^{90}Y similar to the response for ^{137}Cs for some dosimeters that are nearly insensitive to low-energy beta particles. Inclusion of the ^{204}Tl source (0.76-MeV maximum energy) requires that some attention be given to the lower energies. Reference sources with energies lower than that provided by the ^{204}Tl source may be included following improvement in dosimeter technology. The ^{204}Tl source was chosen because of its ease of use and single beta spectrum.

A uranium slab source was added for occupational environments containing uranium and because of the popularity of this source type for dosimeter calibrations. Because source construction details may change dose rates slightly, extrapolation chamber measurements were specified for the calibration at 7 mg/cm^2 and the depth-dose determination at 100 mg/cm^2. Source construction and geometry effects are constrained by the depth-dose specification, which was calculated using measurements reported in the literature,[A-4,A-5] and which were subsequently checked by direct measurement. These measurements indicate that the depth-dose specification can be met for slab sources with protective coatings in the range of 3 mg/cm^2 to 7 mg/cm^2.

The use of dosimeters far from a uranium source may result in inaccurate readings compared to the uranium slab calibration. The slab geometry provides a less-penetrating depth dose distribution than the point source geometry. Proper use of the source calibration can be determined using measurements performed in the occupational environments.

The response ratio of DOE albedo neutron dosimeters for moderated and unmoderated ^{252}Cf irradiations varies from approximately 6 to 20.[A-1] Because the variations are so large, both sources were chosen for use as reference sources. For the performance evaluation, the type of neutron source is provided before the dose equivalents are reported. The moderated ^{252}Cf source was chosen to be consistent with ANSI N13.11. Unmoderated ^{252}Cf irradiations can easily be performed as a variation of the moderated ^{252}Cf irradiations. More

stringent neutron tests may be included following improvements in neutron dosimeter technology.

A.2 Additional Specifications for Beta Calibrations

Beta calibrations are affected by source geometry, source filtration, dosimeter irradiation technique, beam calibration technique, and environmental conditions. The ANSI N13.11 standard specifies inherent source filtration, phantom size, and source-to-phantom distance for $^{90}Sr/^{90}Y$ irradiations but does not adequately address other parameters. Considerable variability in dosimeter response per unit delivered dose has been observed among $^{90}Sr/^{90}Y$ sources set up to ANSI N13.11 specifications. Additional constraints are necessary to standardize beta calibration techniques.

This standard specifies that beta irradiations be standardized according to depth-dose characteristics and source energy criteria in the international standard ISO 6980.[A-6] The specifications for $^{90}Sr/^{90}Y$ irradiation are related to the mean energy of the source (100-mg/cm^2 specification) and Bremsstrahlung production (1000-mg/cm^2 specification). For ^{204}Tl irradiations, only a specification related to mean energy is given (20-mg/cm^2 specification). The depth-dose specifications are intended to take precedence over the source filtration specifications. The intention is to allow the use of source geometries specified in ISO 6980 while maintaining irradiation consistency between laboratories. The depth-dose specification for the slab uranium exposures was added to help control variations in source manufacture and geometry.

A.3 Factors for Converting Exposure to Dose Equivalent for Photons

The exposure-to-dose-equivalent conversion factors for low-energy photons (C_x factors) listed in ANSI N13.11 were derived by Dimbylow and Francis for the four-element ICRU sphere using Monte Carlo calculations.[A-7] For the dosimeter performance tests, the dosimeters are mounted on a slab phantom of methylmethacrylate. Personnel dosimeters are designed to monitor for dose to the tissue of the body on which they are mounted. However, the performance tests require that they monitor for dose to the ICRU sphere while mounted on a slab phantom. This results in the miscalibration of even ideal personnel dosimeters.

The choice of the phantom shape for the specification of C_x factors is not arbitrary, as has been argued.[A-8] The size and shape of the phantom is important for monitoring low-energy photons because radiation is scattered back to the surface. Backscatter can contribute an additional 40% to 50% to the dose at the surface for photon energies between 60 and 100 keV.[A-9] The dosimeter ideally would be able to properly record the level of backscattered radiation and, thus, approximately compensate for fluctuations dependent on the size of the wearer.

The contribution due to backscattered radiation is different for the slab and spherical phantoms. Nelson and Chilton used Monte Carlo calculations to derive the C_x factors for the slab geometry with the ICRU four-element composition.[A-10] Their results agreed closely with the calculations of Dimbylow and Francis (spherical geometry) below 50 keV, but were 20% higher between 80 and 100 keV. This difference accounts for the major discrepancy between the spherical-geometry C_x factors specified in ANSI N13.11 and the available measurements using slab geometry by Yoder et al.[A-11] Nelson and Chilton also performed calculations for the tissue-equivalent plastic used by Yoder et al. for direct measurements of C_x factors using the slab geometry. The significant difference between the calculations for the Yoder plastic and the measurements was at energies below 20 keV. Nelson and Chilton attributed this difference to a higher-energy contamination in the k-fluorescence spectra used by Yoder et al.

Because of the use of slab phantoms for the reference calibrations, conversion factors for the slab geometry are used. The best available data are by Yoder et al. and are listed in Table 2 of the main text.

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APPENDIX B

DERIVATION OF PERFORMANCE CRITERIA

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The specifications of performance criteria were based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[B-1] A direct relationship between the performance criterion and the response of each dosimeter was maintained by expressing the criterion as a confidence limit rather than a calibration bias limit only. The confidence limit concept was also used in ANSI N13.11-1983.[B-2] The goal was to develop a statistic for which there would be a specified confidence that the dosimeter readings would be within a specified interval.

For a large number of dosimeter readings obeying a normal distribution, there is a confidence level, β, for which the readings are within the interval

$$M - Z_\alpha\sigma \text{ to } M + Z_\alpha\sigma \qquad \text{(B-1)}$$

where M is the mean; σ is the (one sigma) standard deviation of the total population; and Z_α is the standard normal variable for $\alpha = 1/2\ (\beta + 1)$. The entire interval may be required to be within a specified tolerance of a conventionally true value (CTV) by stating:

$$M + Z_\alpha\sigma \leq CTV\ (1 + L)$$

and

$$M - Z_\alpha\sigma \geq CTV\ (1 - L)$$

or

$$\frac{|M - CTV|}{CTV} + \frac{Z_\alpha\sigma}{CTV} \leq L \qquad \text{(B-2)}$$

where L is the fractional tolerance interval.

For a performance test using n dosimeters, the bias (B) and the standard deviation (S) of the performance indices are estimates of (M - CTV)/CTV and σ/CTV. Then the test statistic becomes

$$|B_n| + t_{\alpha,\nu} S_{n,\nu} \leq L \qquad \text{(B-3)}$$

where $\nu = n-1$ represents the number of degrees of freedom and the 't' statistic is used as an approximation of the standard normal variable due to the finite number of dosimeters used for the test.

The reasonably achievable test statistic chosen for the performance criterion was

$$|B| + S \leq 0.30 \qquad \text{(B-4)}$$

This statistic can be interpreted in several ways. If $t_{\alpha,\nu} = 1$ for n = 15 dosimeters, then there would be approximately 70% confidence ($\beta = 0.66$, $\alpha = 0.83$ for n = 15) that a dosimeter response would be within 30% of a conventionally true value. However, if a worker used four dosimeters per year and received approximately equal doses on each, then there would approximately 95% confidence ($\beta = 0.93$, $\alpha = 0.97$ for n = 15) that the annual reported dose equivalent would be within 30% of a conventionally true value.

Variations of the test statistic derivation are possible. Higher levels of statistical confidence that a test sample is representative of the true population can be obtained using tolerance statistics.[B-3] An interval can be constructed to cover at least a specified percent of all dosimeter readings in the total population with a desired probability. For example, for a 95% probability that 95% of the averages of four dosimeter readings are within tolerance (assuming uniform occupational exposures and a quarterly exchange rate), the test statistic becomes:

$$|B| + 1.45\,S \leq 0.30 \qquad \text{(B-5)}$$

for 15 sample readings. However, there is also the probability that a system that meets the 30% criteria exceeds the test statistic. For 95% probability that systems meeting requirements also meet the test statistic, the tolerance value (0.30) would have to be increased. Both approaches converge to the adopted test statistic as the number of sample dosimeters approaches infinity.

The relationship of the adopted test statistic (Equation B-4) to recommendations of the NCRP, ICRU and ICRP are given below.

Recommendations to NCRP 57[B-4]

The NCRP recommends several values of precision and accuracy depending on the circumstance. The recommended precision is ± 10% which allows comparison of reported values between individuals and over long periods of time. For reported values near the maximum permissible dose (MPD), an accuracy of ± 30% is recommended. For reported values less than 1/4 of the MPD, an accuracy of a factor of 2 is acceptable. At higher doses encountered during emergency procedures or accidents, an accuracy of better than ± 20% is recommended.

The precision of the reported values approximately corresponds to the 'S' value. While the test statistic does not require an S of 0.10 or less, there is an implied constraint on S of about 0.12 to 0.15. Larger values of S do not allow sufficient latitude for a minimal uncertainty in the bias, especially for multipurpose dosimeters which require some latitude in the bias to cover response variation as a function of radiation type and energy. The spirit of the recommendation for precision is accommodated.

The recommended accuracy near the MPD of 30% is implied to be used annually, since the MPD is applied annually. If a facility uses quarterly dosimeter exchanges, dosimeters receiving approximately equal doses per quarter would meet the 30% recommendations with approximately 95% confidence. The reported dose equivalent for a worker receiving all of the annual dose on one dosimeter would have an approximately 70% confidence of meeting the recommendation.

A test statistic variable in the magnitude of the delivered dose was contained in the early drafts of ANSI N13.11. The University of Michigan test concluded, and the DOE study concurred, that the split in the test statistic was unnecessary at current state of the art and was detrimental to the conduct of the test. Principally, a significantly larger number of dosimeters would be required to perform a variable-criteria test compared to a single-criteria test to achieve the same level of confidence in the results. Therefore, the allowance for a greater inaccuracy at lower doses was not included in the test criteria.

The test statistic does not meet the ± 20% recommendation on the accuracy at high doses. High doses are typically received by only one dosimeter, thus there would be 70% confidence that the reported dose is within 30%.

Recommendations in ICRU 20[B-5]

The ICRU recommends that an accuracy of ± 30% be achieved when the maximum dose equivalent is comparable to the maximum permissible dose. At a level of 0.1 of the maximum permissible dose, a maximum allowable uncertainty of a factor of three is suggested. At doses much greater than the maximum permissible dose, the ICRU recommends that the accuracy be increased, possibly with special effort applied postexposure.

The accuracy recommended by the ICRU is similar to that quoted by the NCRP at radiation protection levels. At high doses, the ICRU encourages the use of special efforts to improve the dose estimate for each individual worker. The adopted test criteria is in approximate agreement with these recommendations. However, there is no test requirement to demonstrate the ability to improve the accuracy after the exposure.

Recommendations in ICRP 35[B-6]

The ICRP recommends that the uncertainty in the annual reported dose equivalent be reduced as far as is reasonably achievable. It further recommends minimum levels of accuracy of a factor of 1.5 at the 95% confidence limit when the dose equivalent is on the same order as the annual maximum permissible dose, or within a factor of two at the 95% confidence level when the annual reported dose is less than 1 rem. Explicitly stated is that these accuracy limits include variations in dosimeter sensitivity, with incident energy and direction of incidence, and in dosimeter construction, readout, and calibration.

The first recommendation is met: the criteria was designed to be as low as is reasonably achievable. The recommended minimum levels of accuracy near the maximum permissible dose imply a test statistic of

$$|B| + 2S \leq 0.50 \text{ for B positive}$$

and (B-6)

$$|B| + 2S \leq 0.33 \text{ for B negative.}$$

The asymmetric criterion is due to the specification of a factor rather than a percent of the conventionally true value. This statistic implies an upper limit of S of 0.25, which is approximately achieved by

the adopted statistic (S_{max} = 0.30). The adopted criteria approximately corresponds to recommendations of the ICRP for S values near 0.20. However, the allowed inaccuracy of the bias for small S values is (nearly) as great as 50%. This allows too much inaccuracy in the calibration methods and dosimeter design, and is above the currently achievable level. Note that this approach does not require the use of quarterly dosimeter exchanges with the accompanying assumption of approximately equal doses received each quarter.

A source of inaccuracy included by the ICRP, but not included by the adopted test criteria is that due to direction of radiation incidence. The collection of angular response data is required by the DOE standard with no criteria on the performance. The application of the adopted test statistic may be alternatively viewed as allowing a confidence interval up to 0.2 for the inaccuracy in the angular response. The recommendations of the ICRP can be taken into account during the development and subsequent review of a test criteria for angular response.

The recommendations at the lower dose equivalent levels were not used for the same reason as was stated above for the NCRP recommendations.

Summary of Relationship to NCRP/ICRU/ICRP Recommendations[B-4 through B-6]

The adopted performance criteria were chosen to be as low as was reasonably achievable. The criterion is consistent with the recommendations of the NCRP,[B-4] ICRU,[B-5] and ICRP[B-6] with the following caveats:

- To meet the NCRP and ICRU recommendations of 30% for the accuracy, and do it with 95% confidence, at least four dosimeters receiving equal doses must be used. This may be approximately correct for the majority of workers, but is not adequate for all.
- The recommendations by the ICRP are approximately met for each dosimeter, and thus for each worker, except that the uncertainty due to angular response is neglected in the test criteria. The adopted test criteria are approximately equivalent to reserving up to 20% for additional (positive) bias due to angular response variations.
- The NCRP recommended accuracy in the high dose region is greater than is specified by the test criteria (20% NCRP versus 30% test criteria). The ICRU and ICRP favor special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions (e.g., position of dosimeter relative to the source distribution and body of wearer) are neglected in the test criteria.

Performance Test Uncertainty

The implementation of the test statistic as given in Equation (B.4) may require large numbers of dosimeters to measure |B| and S with sufficient precision. Assuming that the dosimeter readings are normally distributed about a single mean, for 95% of the readings the magnitude of the bias is bounded by:

$$|B| \le \frac{|M - CTV|}{CTV} + \frac{Z_{0.975}}{\sqrt{n}} \frac{\sigma}{CTV} \qquad \text{(B-7)}$$

For 95% of the samples the standard deviation is approximately bounded by:

$$S \le \left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} \cdot \frac{\sigma}{CTV} \qquad \text{(B-8)}$$

using a χ^2 distribution with (n - 1) degrees of freedom. Because the uncertainties in B and S are independent for normally distributed data, a close approximation to the interval containing 95% of the parent population is:

$$[|B| + S]_{max} = \frac{|M - CTV|}{CTV} + \frac{\sigma}{CTV} + \left\{ \left(\frac{Z_{0.975}}{n} \right)^2 + \left[\left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} - 1 \right]^2 \right\}^{1/2} \frac{\sigma}{CTV} \qquad \text{(B-9)}$$

The term in brackets on the right-hand side is the amount by which a system that meets the goals for accuracy could fail the test statistic due to a statistical fluctuation of a measurement. This term can be

Table B-1. Statistical uncertainty term

σ/CTV	Number of Dosimeters	Approximate Value of Uncertainty Term
0.08	15	0.05
0.17	15	0.10
	30	0.17
	60	0.05
0.24	15	0.14
	30	0.10
	60	0.07
	120	0.05

reduced by increasing the number of dosimeters per test. Table B.1 lists the approximate values of the statistical terms as a function of σ and the number of dosimeters used per test. For an uncertainty of 5%, 15, 60, and 120 dosimeters are required for standard deviations of 0.08, 0.17, and 0.24, respectively. Similar requirements for the number of sample dosimeters can be derived using tolerance statistics for 95% probability that 70% of a parent population with $|B| + S = 0.25$ is within tolerance.

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HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health

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FOREWORD

The program contained in this Handbook provides a significant advance in the field of radiation protection through a structured means for assuring the quality of personnel dosimetry performance. This program culminates an effort initiated by DOE's predecessor in early 1963. Since personnel dosimetry performance is directly related to the assurance of worker safety, it has been of key interest to the Department of Energy (DOE) (and its predecessor agencies). Studies conducted over the past three decades have clearly demonstrated a need for personnel dosimetry performance criteria, related testing programs, and improvements in dosimetry technology. In responding to these needs, the DOE Office of Nuclear Safety (EH) has developed and initiated a DOE Laboratory Accreditation Program (DOELAP) which is intended to improve the quality of personnel dosimetry through (a) performance testing, (b) dosimetry and calibration intercomparisons, and (c) applied research.

In the interest of improving dosimetry technology, the DOE Laboratory Accreditation Program (DOELAP) is also designed to encourage cooperation and technical interchange between DOE laboratories. Dosimetry intercomparison programs have been scheduled which include the use of transport standard instruments, transport standard radioactive sources and special dosimeters. The dosimeters used in the intercomparison program are designed to obtain optimum data on the comparison of dosimetry calibration methodologies and capabilities. This data is used in part to develop enhanced calibration protocols. In the interest of overall calibration update, assistance and guidance for the calibration of personnel dosimeters is available through the DOELAP support laboratories.

To further the efforts in dosimetry upgrade we are also encouraging a closer cooperation and working relationship between the researcher and those involved in performance testing. Feedback to the DOE dosimeter processors on dosimeter performance and applied research efforts will be provided by DOELAP.

The relationship between the DOELAP and the NVLAP (National Voluntary Laboratory Accreditation Program) which services NRC licensees has also been established. The DOE recommended to the Interagency Policy Committee on Personnel Dosimetry, a program, which integrates the DOELAP and NVLAP under the National Dosimetry Accreditation Upgrade Program through an efficient flow of information between the programs. The DOELAP and NVLAP utilize similar methodology. However, the DOELAP is more comprehensive through necessity because of the complexities of the DOE programs to be accredited and the need for more restrictive performance testing.

The DOELAP is basically contained in four documents:

1. "DOE Order 5480 Series,"
2. "Department of Energy Standard for the Performance Testing of Personnel Dosimetry Systems" (provides testing criteria to accredit personnel dosimeters) - DOE/EH-0027,
3. "Handbook for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (provides operating procedures for program), and
4. "Quality Assurance Manual for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (applies to the performance testing laboratory only) - DOE/ID-12105.

E. J. Vallario, Group Leader
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HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

The Department of Energy (DOE) and its predecessor agencies have been concerned about personnel dosimetry performance since the late 1950s. Studies conducted over the past three decades have clearly demonstrated DOE needs both performance criteria for personnel dosimetry and a testing program to determine the criteria have been met.[1-13]

In 1973, the Conference of Radiation Control Program Directors recommended establishing a program for continually testing personnel dosimetry performance throughout the United States. The Conference appointed a task force with state and federal participants to implement this recommendation. The task force concluded that existing standards were inadequate for the purpose. It asked the Health Physics Society Standards Committee (HPSSC) to develop a new Standard to establish criteria for testing personnel dosimetry performance. In 1975, HPSSC charged a working group with writing such a Standard for the American National Standards Institute as ANSI Standard N13.11.[14]

In 1976, the Conference of Radiation Control Program Directors, the Nuclear Regulatory Commission (NRC), predecessor agencies of DOE, and the National Center for Devices and Radiological Health (NCDRH) jointly sponsored a public meeting. This meeting was held to discuss the problems associated with personnel dosimetry. At that meeting copies of the draft standard *Criteria for Testing Personnel Dosimetry Performance*, which HPSSC had developed, were distributed. Many of those attending the meeting strongly recommended a pilot study be undertaken to evaluate the draft standard. As a result of that recommendation, the University of Michigan conducted three rounds of personnel dosimetry proficiency testing from 1977 to 1982. Upon completion of the University of Michigan studies, the standard was adopted as a Health Physics Society Standard. The Board of Standards Review of ANSI accepted it as a final American National Standard.[14] The National Voluntary Laboratory Accreditation Program (NVLAP) is using it as a basis for an accreditation program for personnel dosimeters.[15]

Independent of the University of Michigan testing program, DOE conducted a program to evaluate ANSI N13.11 for use in its DOE/DOE contractor personnel dosimetry programs. The studies DOE conducted have demonstrated ANSI N13.11 is not adequate for testing the personnel dosimeters used at DOE/DOE contractor facilities.[12] Accordingly, DOE developed a comprehensive Standard for performance testing its personnel dosimetry systems.[16] The Standard is a modification of ANSI N13.11[14] and is based on recommendations made while evaluating the ANSI Standard. Moreover, DOE wanted a testing program that would encourage further research and promote communication among the DOE/DOE contractor organizations. This kind of program would bring about new developments and procedures to be used to improve dosimetry performance. Therefore, DOE decided to establish a dosimetry testing program consistent with its needs. The program is called the DOE Laboratory Accreditation Program (DOELAP). DOE intends to eventually coordinate its testing program with that of NVLAP. Therefore, DOELAP follows NVLAP methods and procedures as much as possible.

Accreditation is the assessment of whether or not a personnel dosimetry system meets specific criteria. The assessment includes dosimeter performance and the associated quality assurance and calibration programs. The accreditation process includes the development of recommendations for any improvements needed to ensure continuing quality. DOELAP's objective is to accredit the personnel dosimetry systems of DOE/DOE contractors, regardless of whether the dosimeter processing is conducted at commercial or in-house facilities. The term "DOE contractor" will refer to the DOE/DOE contractor facility eligible for accreditation. The term "processor" is limited to the facility handling and evaluating the personnel dosimeters.

This handbook describes the procedures for obtaining accreditation. In general, to obtain accreditation, contractors must:

1. Meet the test criteria in the DOE Standard
2. Pass an onsite assessment of the documentation, quality assurance, and technical adequacy associated with personnel dosimetry systems.

A performance testing laboratory determines the ability to meet the test criteria. Members of a team of experts in personnel dosimetry conduct onsite assessments. The Standard is consistent with the current capabilities of dosimetry systems. However, it will be upgraded as improved dosimetry capabilities become available. This particularly applies to beta-particle and neutron dosimetry.

2. SCOPE OF ACCREDITATION PROGRAM

The DOELAP for personnel dosimetry systems applies to the technical aspects of personnel dosimetry systems at DOE/DOE contractor facilities and to the documentation of those aspects. During the accreditation:

1. A performance testing laboratory evaluates the technical performance of dosimetry systems
2. An onsite assessment studies the quality assurance, documentation, and technical adequacy of such systems.

Dosimeter types or models used to determine whole-body and skin dose for personnel are included in the scope of the Accreditation Program. Accreditation currently does not apply to extremity dosimeters, pocket ionization chambers, thermal neutron dosimetry, and high-energy neutron dosimetry. The program scope does not forbid a laboratory to provide additional dosimetry services (i.e., personnel, extremity, environmental, or area monitoring). Nor does it preclude a laboratory from operating research programs to improve the dosimetry services. Calibration services are accessible, for a fee, to laboratories requiring characterization of dosimetry systems in routine use or under development.

The DOELAP allows abbreviated testing for dosimeter types known or suspected to be noncompliant in certain categories. The dosimeter type will be considered adequate or accreditable only if it is used in those environments covered by the categories for which it was successfully tested.

The DOELAP test standard scope is limited. Approximate energy intervals covered are: 15 keV to 2 MeV for photons; above 0.3 MeV for beta particles; and 1 keV to 2 MeV for neutrons. Additional test categories covering other energy ranges are being developed as the need arises and time permits. DOELAP does not currently cover occupational environments containing significant contributions outside these ranges. Processors are not required to test dosimeters used for these environments.

Every two years, each DOE contractor must maintain its accreditation by demonstrating compliance with DOELAP criteria.

3. ADMINISTRATION OF THE PROGRAM

The DOELAP is managed by the DOE Office of Nuclear Safety. The DOE Headquarters (HQ) DOELAP Administrator provides for the overall program management. An Oversight Board technically reviews DOELAP protocol and makes recommendations concerning accreditation. The Oversight Board consists of five DOE/DOE contractor personnel. Each serves a 2-year term. An Appeals Board considers contractor appeals concerning accreditation denial. It consists of six DOE/DOE contractor personnel. The performance evaluation program at the DOE Radiological and Environmental Sciences Laboratory (RESL) at the Idaho National Engineering Laboratory (INEL) coordinates the accreditation process. The Performance Evaluation Program Administrator at RESL is responsible for conducting the performance testing and site assessment programs and for maintaining all documentation associated with DOELAP.

The HQ DOELAP Administrator will periodically request nominations for a pool of technical experts to serve in this accreditation program. The experts are selected by evaluating their professional and academic achievements and their experience in dosimetry. The onsite assessors, members of the Oversight Board, and of the Appeals Board are selected from this pool. Each board will select its own chairman.

4. ACCREDITATION PROCESS

The Performance Evaluation Program Administrator coordinates the accreditation process for personnel dosimetry systems. To obtain accreditation, a DOE contractor must first submit an application through the field office. The contractor must then satisfy both the performance testing and the onsite assessment requirements. The Performance Evaluation Program Administrator prepares an administrative report documenting the test results and recommendations for accreditation. The Oversight Board evaluates the report and the recommendations and, if approved, sends them to the HQ DOELAP Administrator. The HQ DOELAP Administrator makes the final decisions on accreditation and issues the Certificates of Accreditation. A Certificate of Accreditation specifies the model(s) or type(s) of dosimeters accredited for specific radiation categories.

If a dosimetry system, or part of a dosimetry system, is found noncompliant with DOELAP criteria, the contractor and field office prepare a remedial action plan to implement immediately. The plan is sent through the DOE field office to the HQ DOELAP Administrator with a copy to the Performance Evaluation Program Administrator. The contractor and field office may appeal to the Appeals Board at any point in the accreditation process. In the meantime, the dosimetry system may be partially accredited. If the system has demonstrated satisfactory performance in a subset of the DOELAP irradiation categories and if the remedial action plan is initiated, the accreditation process may continue in those categories. When more than one dosimeter design is used to meet the special needs at a laboratory, it is possible for a portion of a dosimetry system to receive final accreditation while the remaining part requires a remedial action plan.

If a DOE contractor uses the services of a commercial processor, both the contractor and processor facilities will be visited. If more than one DOE contractor is using the same commercial processor, only one site visit to the processor may be required. More than one DOE contractor may use performance test data for a commercial processor if each contractor facility uses the identical dosimeter design and if the appropriate test categories are included. Site-specific calibration factors and response algorithms are required if used for routine evaluations. The Performance Evaluation Program Administrator must approve combined evaluations, and the Oversight Board must review them.

The following sections describe the phases of the accreditation process in more detail.

4.1 Application

The contractor initiates the accreditation process by submitting an application form (Appendix A) through the appropriate field office. To expedite the process, a designated representative of the applying laboratory management (e.g., the laboratory's head health physicist) should complete the application as thoroughly as possible and sign it. The designated representative should be familiar with all DOELAP requirements. The representative reviews all documents and acts as liaison between DOE/DOE contractor management and the Performance Evaluation Program Administrator. Other staff members may be designated to perform specific activities (e.g., handling proficiency testing or receiving an assessor). Yet, only one designated individual should be responsible for requesting a change in the scope or nature of the accreditation.

The application requires each applicant to describe the particular processing system employed. The description should include the specific apparatus and protocols used and whether processing is done manually or automatically. It should also identify the equipment and procedures to be used for the appropriate testing categories. The information submitted should describe the system used as thoroughly as possible without divulging proprietary information.

The application is used to:

- Enroll the DOE/DOE contractor facility in the program
- Determine the dosimeter types or models and test categories desired for accreditation
- Gather information about the DOE/DOE contractor's facility and organizational structure for evaluation purposes
- Select assessors with the proper technical background for the onsite visit
- Gather information necessary to prepare for an onsite visit.

The contractor sends the application to the appropriate field office. There, it is reviewed and, if approved, sent to the Performance Evaluation Program Administrator.

4.2 Performance Test

Performance testing is the first requirement of the DOELAP accreditation process. The procedures contained in the DOE Standard are briefly highlighted in this section.

A dosimeter type may be accredited in one or more of the radiation categories shown in Table 1. This table contains the source specification, energies, and dose range for each category. The contractor must specify the exposure categories and the types or models of the dosimeters submitted for accreditation.

The test period is three to six months. The contractor must submit three shipments of dosimeters during this test period to the performance testing laboratory for irradiation. The contractor shall normally submit five dosimeters in each test category with each shipment. The contractor will be required to include a specified number of additional dosimeters of each design in each shipment to be used as controls and when necessary as replacements. The Standard specifies certain cases where 10 dosimeters per category per shipment may be submitted for irradiation. These cases must be coordinated with the DOELAP Performance Evaluation Program Administrator.

The dosimeters are then irradiated and returned to the contractor. The contractor must read each one and determine a dose or dose equivalent. The testing laboratory will identify all dosimeters irradiated in Categories I and II and those irradiated for the neutron tests (Categories VI & VII). Dosimeters irradiated in the mixture categories Categories III, IV, and V and VII (not including neutron irradiations) are not identified by category. In these cases, the processor must determine the dose for each dosimeter without knowing the irradiation category. Pretest calibration exposures for neutron categories are recommended and will be provided upon request. The contractor will identify the neutron field(s) to be used for the performance testing. Besides identifying the dosimeters irradiated by the neutron sources to the contractor, the testing laboratory will provide the ratio of responses of a BF_3 detector in a 9-in.-dia sphere and in a 3-in.-dia sphere covered with 10-mil-thick cadmium. The ratio gives the contractor a relative calibration for albedo dosimeters. This information may be useful to relate the test fields to the neutron fields in the occupational environment.

The radiation sources and geometries are described fully in the Standard. A brief description of them follows:

1. A sealed ^{137}Cs gamma-ray source
2. X-ray machine(s) producing continuous spectra using the techniques of the National Bureau of Standards,[18] and capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV).
3. A sealed $^{90}Sr/^{90}Y$ beta particle source with a 100-mg/cm^2 filter (nominal) to remove the ^{90}Sr component - The residual maximum energy, as defined in the International Standard ISO 6980,[19] shall equal or exceed 1.80 MeV. The in-phantom dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 1.01 ± 0.03. The in-phantom dose rate at 1000 mg/cm^2 shall be less than 1% of the dose rate at 7 mg/cm^2. The measurement specifications take precedence over the irradiation geometry specifications.
4. A sealed ^{204}Tl source filtered by 50 mg/cm^2 (nominal) - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV. The in-phantom dose rate at 20 mg/cm^2 divided by the in-phantom dose rate at 7 mg/cm^2 shall be 0.80 ± 0.05. The measurement specifications take precedence over the irradiation geometry specifications.
5. A natural or depleted uranium slab - The source protective covering shall be in the range between 3 mg/cm^2 and 7 mg/cm^2 inclusive. The dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 0.58 ± 0.04. The measurement specifications take precedence over the geometry specifications. The dimensions of the source must exceed the dimensions of irradiated dosimeters.
6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[17]

The Standard of performance for DOELAP is based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically

Table 1. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 1. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]	One energy from each category	0.05-5 rem	Shallow, Deep
III & V		0.2-5 rem	
IV & V[a]		0.2-5 rem	
III & VI[h]		0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 14.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 17).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[13] A test criterion:

$$| B | + S \leq 0.30^{a} \qquad (1)$$

can be interpreted as providing approximately 70% confidence a dosimeter response would be within 30% of a conventionally true value. For workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence the annual reported dose equivalent would be within 30% of a conventionally true value.

The criterion in Equation (1) is consistent with the recommendations of the National Council on Radiation Protection and Measurement (NCRP), the International Commission on Radiation Units and Measurements (ICRU), and the International Commission on Radiological Protection (ICRP). Reference 16 points out the following caveats:

- The NCRP and ICRU recommend 30% for the accuracy with 95% confidence. To meet these requirements, at least four dosimeters receiving approximately equal doses must be used to determine the annual dose.
- The recommendation by the ICRP of accuracy within a factor of 1.5 at the 95% confidence level is approximately met for each dosimeter (and thus for each worker). However, the uncertainty due to angular response included in the ICRP accuracy recommendations is neglected in the test criteria. The criterion in Equation (1), using quarterly exchange rates to achieve 95% confidence, is the approximate equivalent of reserving up to 20% additional bias for angular response variations.
- The NCRP recommends 20% accuracy at high doses. The ICRU and ICRP favor a special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions are neglected in the test criterion. Examples of such unknowns are the position of dosimeter relative to source distribution or its location on the body of the wearer.

The criterion in Equation (1) was modified to reduce the probability of a failure due to the imprecise delivery of dose equivalent to the test dosimeters and to permit more time for fine adjustments in the mixture categories. The DOELAP Test criterion is:

$$| B | + S - | E | \leq L \qquad (2)$$

where

$L = 0.30$ for Categories I through VI

$L = 0.40$ for Category VII

and E is the estimated fractional uncertainty in the delivered dose or dose equivalent rate. The performance testing laboratory determines the value of E. It will typically be in the range between 1% and 4%.

The test for the low-energy beta source listed in Table 1 does not require using Equation (2) because of the technological and practical limitations of current dosimeter designs. Instead, this less stringent test is used for ^{204}Tl:

$$| B | - | E | \leq 0.40 . \qquad (3)$$

---

a. Bias (B) - the average of the performance quotients, P_i, for n dosimeters, for a specific irradiation category and depth.

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1a)$$

where

$$P_i = \frac{(\text{Reported})_i - (\text{Delivered})_i}{(\text{Delivered})_i}$$

Standard Deviation (S) - The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth.

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)^2}{n - 1} \right]^{1/2} \qquad (1b)$$

This criterion was chosen based on the low-energy beta performance of current DOE dosimetry systems, as discussed in the Standard.[16] The ^{204}Tl source is not used in any mixture categories unless requested by a participant. The performance criteria for Category VII and for the ^{204}Tl tests will be upgraded to that of the other categories and sources two years after the effective date of the DOE Order.[20]

The dose interpretation algorithms used for reporting occupational doses should be used for the performance tests, if practical. If changing an algorithm to meet the DOE Standard specifications increases the error of reported occupational doses, that algorithm should not be changed. Using different calibration factors for the tests and for various occupational environments is justified if it results in an improved dose estimation. The contractor must document the relationship between the algorithms used for the test and the reported worker doses. The contractor must also justify the use of environment-dependent factors.

The categories for low-energy photon and beta particles offer a choice of sources. The "A" categories are for general sources, the "B" or "C" categories for specific occupational environments or applications. For example, Category IIIA is for general low-energy photon environments. Category IIIB applies specifically to plutonium environments. Testing in both subgroups of Category III is appropriate for a dosimeter used in both plutonium and nonplutonium environments with significant x-ray fields. Different dose interpretation algorithms may be used for Categories IIIA and IIIB if they are the same ones used to estimate the occupational doses.

The beta particle categories are for general beta environments ($^{90}Sr/^{90}Y$ and ^{204}Tl point sources—Category VA), environments containing uranium sources (slab uranium—Category VB), and environments having predominantly high-energy or low-energy betas (a $^{90}Sr/^{90}Y$ or a ^{204}Tl point source—Category VC). The sources in Category VA have energy spectra suitable for an energy response test for beta fields. According to Reference 19, an energy response test may include ^{147}Pm, ^{204}Tl, and $^{90}Sr/^{90}Y$ sources. These are contained in the ISO series 1 sources, designed for dose rate uniformity over large areas. The Category VB source may be preferable in a dosimetry system designed to monitor uranium fields when a similar source is routinely used for beta dose standardization.

The exposure geometry from contact with a slab produces a different depth dose curve from the curve obtained at a distance from a point source. Present dosimeter designs may require calibration factors for occupational environments that are significantly different from the slab uranium source factors. The contractor is responsible for demonstrating that calibration obtained from the slab uranium source is appropriate. Category VC may be preferable if the occupational environment contains only limited beta energy ranges. The limited range must be identified as being closer to the energy of $^{90}Sr/^{90}Y$ or of ^{204}Tl. The contractor chooses the beta source in Category VC before initiating the test. If more than one of Categories VA, VB, and VC are chosen, the contractor may use different dose-interpretation algorithms when those same algorithms are used for specific occupational environments.

After each shipment of dosimeters is returned, the contractor determines the dose for each dosimeter and reports the doses to the performance testing laboratory. When all three rounds have been completed, the performance testing laboratory mails the results of the proficiency testing to the contractor. If the contractor does not demonstrate satisfactory performance in one or more categories during a test sequence, the laboratory will send the contractor a notice of required retesting with the test results.

For each dosimeter type, the retest sequence is as follows:

1. Categories I and II - When a contractor tests in both high-dose categories and the test result is not satisfactory in one or both, retesting in both is required. When a contractor tests in only one high-dose category and the test result is not satisfactory, retesting in that category is required. Whenever the test result is not satisfactory for a high-dose category, retesting in the corresponding protection level category (III or IV) is also required.
2. Categories III, IV, V, VI, and VII - When a contractor tests in three or fewer protection level categories and the test result is not satisfactory in one of these, the contractor must retest in all of them. A second case occurs when a contractor tests in more than three protection level categories, and the test result is not satisfactory in one of these tests. Then the contractor must retest in that category and in two additional

protection level categories for which their performance was satisfactory. The contractor will not know which two additional categories are chosen. Finally, when performance is not satisfactory in two or more protection level categories, retesting is required in all protection level categories for which accreditation is sought.

4.3 Onsite Assessment

To become accredited, a contractor must demonstrate the ability to conduct a credible personnel dosimetry program. For initial accreditation, an onsite visit is required after the performance testing has been satisfactorily completed. This visit shall assess the quality assurance, documentation, and technical aspects of the personnel dosimetry program. Appendix B contains the assessment criteria. Assessors may use them with considerable latitude according to their experience and as the unique conditions at each processing facility may dictate. The onsite assessment is repeated at least every two years.

Two assessors are assigned to visit each facility. Assignments are based on how well the assessors' individual experience matches the type of processing to be assessed. Assignments also are made to avoid conflicts of interest. The contractor is told of the assignments and has the right to appeal the assignment of an assessor to the Performance Evaluation Program Administrator. If the contractor and the Program Administrator cannot agree on an assessor, they may ask the Appeals Board to resolve the difference. When the assessors have been assigned, the Program Administrator contacts the contractor to arrange a mutually agreeable date for the visit. The field office is notified of the dates of the site visit. The time needed to conduct an onsite visit varies. A two-man team typically requires two to three days.

The assessors:

1. Begin the visit by meeting with the management and the supervisory personnel responsible for the dosimetry activities for which accreditation is being sought. The assessors acquaint management with the assessment process and set the agenda for the visit.
2. Evaluate the contractor's quality assurance system.
3. Select and trace the history of a sample batch of dosimeters from when the dosimeters are received to the time a dose report is issued.
4. Thoroughly review the contractor's performance test results.
5. Review the contractor's quality assurance documentation.
6. Examine technicians' notebooks for records about the selected group of dosimeters.
7. Check dosimeter identification and tracking procedures.
8. Determine if the appropriate environmental conditions are maintained.
9. Examine copies of completed reports.
10. Evaluate documentation.
11. Evaluate technical aspects. These include: personnel training and competency, facilities and equipment, equipment calibration and maintenance, and record-keeping systems.
12. Conduct a close-out meeting with management and supervisory personnel to explain their findings and to clarify the contractor's responsibilities.
13. Leave a copy of their reports with the contractor.
14. Conduct monitoring visits between the biennial assessments.

The following subsections discuss some of these activities. Subsections 4.3.1 through 4.3.3 provide a general overview of the program elements assessors are likely to consider important components of a satisfactory dosimetry program. Subsections 4.3.4 through 4.3.6 discuss the close-out meeting, procedures for correcting deficiencies, and monitoring visits.

4.3.1 Quality Assurance Program. The key to a properly functioning organization is an ongoing quality assurance (QA) program. A QA program is an organization's internal system of procedures and practices to ensure the quality control of its services. A QA manual should document this program. To qualify for accreditation, a contractor must demonstrate its QA program during the onsite visit. Criteria for the QA program are contained in Appendix B.

4.3.2 Documentation. A contractor must have up-to-date documentation thoroughly describing all of its significant procedures and practices. These

written descriptions should contain such items as: (a) personnel requirements and responsibilities, (b) a system for maintaining necessary records, (c) operating procedures, (d) procedures to employ in the event of unusual or nonstandard circumstances, and (e) scheduling. Written descriptions should cover at least these topics:

Personnel

- Organizational chart
- Job/position description for all dosimeter-processing and records-management personnel
- Procedures for training personnel
- Assurance of personnel competency

Equipment

- Processing-equipment inventory, including radiation sources used for calibration
- Practices for processing-equipment calibration, verification, and maintenance
- A test plan (processing protocol) for the conduct of the performance tests for each dosimeter design processed
- Instructions for operating all processing equipment, including instructions for performing operational quality assurance checks

Dosimeters

- Dosimeter models and design specifications
- Acceptance criteria for incoming dosimeter holders and materials
- Procedures for handling and storing sensitive dosimeter components and materials
- Assembly/disassembly techniques for all dosimeter models used
- Procedures for periodic checks of in-service dosimeters
- Identification and tracking of dosimeters
- Procedures for handling and storing in-service dosimeters
- Actions to repair or replace damaged dosimeters

Calibration

- Relationship(s) between dosimeter calibrations and field spectra
- Dosimeter calibration techniques and procedures, including traceability paths

Reporting

- Data handling and reporting
- Actions to be taken when variations in test data indicate a problem.

4.3.3 Technical Adequacy. Contractors must ensure employees do their jobs well by having adequate procedures for training and utilizing employees. Contractors must also provide adequate equipment, facilities, and maintenance procedures.

4.3.3.1 Personnel Training. The contractor must ensure each new staff member is trained for the processing duties assigned. The competency of staff members should be verified and documented annually. In addition, all staff members should be retrained when processing equipment and protocols are changed or when the staff members are assigned new responsibilities.

Each staff member must receive (or have had) training for the assigned duties through on-the-job training, formal classroom sessions, or a technician certification program. This training should be documented in the personnel file.

4.3.3.2 Personnel Competency. The technical director of the personnel dosimetry program should be a professional experienced in applied radiation dosimetry. He/she should be knowledgeable in the design and operation of the dosimetry system(s) currently utilized. This individual should have the technical competence to establish any required dosimetry programs. He/she should also have the supervisory capability to direct the work of professionals and technicians in the dosimetry area. The technical director may be responsible for the quality assurance program. If not, responsibility is assigned to another individual. This person should have knowledge and experience in quality assurance. He/she will communicate directly to the technical director and other organizational management. If a second individual has responsibility for the QA program, the description for that position should be included in the organization description. There should be enough trained staff members to provide program continuity.

In addition to providing for staff training, the technical director must annually evaluate the competency of each staff member authorized to perform

dosimeter evaluations. These staff evaluations should be available for review.

The DOELAP Performance Evaluation Program Administrator must be informed of any organizational or personnel changes that could affect the performance of the contractor's dosimetry program. Changes such as technical supervision or responsibility for quality assurance program should be reported to this Administrator within 60 calendar days of the change.

4.3.3.3 Facilities and Equipment. The contractor or dosimeter processor must have facilities and equipment adequate to perform the type(s) of processing for which it claims capability. Proper shielding should be provided to protect areas from unwanted radiation, and environmental controls should be maintained. The equipment should include adequate processing equipment and radiation sources. If properly calibrated (NBS-traceable) laboratory-standard equipment for determining dose equivalent is not available, the contractor should have access to the services of a competent calibration laboratory.

Adequate backup equipment or systems for key processing steps should be available for use in the event the primary systems fail. The backup system could be arranging for the services of another DOE-accredited contractor on an emergency basis.

4.3.3.4 Equipment Maintenance and Calibration. The contractor must maintain a preventive maintenance program for equipment used to process dosimeters and to perform quality control checks. When equipment—used for measurement, dosimeter processing, or quality control—is inherently subject to change due to use or the passage of time, it must be calibrated periodically. Calibration is comparing the equipment with a reference standard. This comparison determines the performance of a measuring instrument or the output of a radiation source with sufficient accuracy.

The proper performance of the dosimetry processing system must be verified periodically. Dosimeters irradiated in well-characterized radiation fields are used for this purpose.

Either the contractor or an external calibration service should calibrate equipment or the dosimetry system and characterize radiation fields. All calibrations and characterizations must be performed using reference standards traceable to NBS national standards[18] or to standards maintained by an equivalent foreign national standards authority. Being traceable means being able to show that appropriate documented actions were taken to compare (either directly or indirectly) a reference standard with a national standard.

The transfer standards used and the environmental conditions at the time of calibration must be documented for all calibrations. Calibration records must be made available for inspection during the assessors' onsite visit. The traceability of the reference standards used are verified at that time.

4.3.3.5 Recordkeeping. The contractor must maintain functional records on the dosimetry system. This means the records should be easily accessible, in some logical order, and complete. Records covering the following items are required and are reviewed during the onsite visit:

- Staff training dates and results
- Staff competency review
- Processing-equipment calibration and maintenance
- Data used to develop dosimeter processing algorithms
- Results of inspection of incoming dosimeter materials
- Logs of processing activities
- Results of internal and external equipment checks, measurement quality assurance programs, audits, etc.
- Performance test data and reports
- Tracking and logging dosimeters.

Processing-equipment calibration (or verification) records should include the following: equipment name or description; model, style, or serial number; manufacturer; notation of all equipment variables requiring calibration or verification; the range of calibration/verification; the resolution of the instrument and its allowable error; calibration or verification date and schedule; date and result of last calibration; identity of the laboratory individual or external service responsible for calibration; source of reference standard and traceability.

Dosimeter-tracking and -logging records should trace the movement of each dosimeter through the processing facility, from its receipt through all the tests performed to the final report.

The final dose report the contractor developed for the permanent record should include or reference the location of the following:

- Name and address of contractor

- Pertinent dates and identification of dosimeter, including contractor and corresponding processor identification codes
- Description and identification of the dosimeter and/or elements
- An explanation of any deviation from the protocol routinely used in processing dosimeters that may affect the reported dose (e.g., mishandling of background control dosimeters)
- Identification of anomalies
- Signature of or a reference to the person having technical responsibility
- All additional items identified in the contractor's test plan.

4.3.4 Close-Out Meeting. At the conclusion of the visit, the assessors will discuss their observations with appropriate members of management and identify any findings or deficiencies. A written summary of any deficiencies discussed is left with the contractor's authorized representative. The assessors forward the assessment forms and the written summary to the DOELAP Performance Evaluation Program Administrator for use in the technical evaluation. The contractor is requested to forward within 30 days a written plan for resolving identified deficiencies. This plan should be sent through the field office to the Performance Evaluation Program Administrator.

4.3.5 Deficiencies. Deficiencies identified during the initial onsite visit may require some time to correct. These corrections must be completed before accreditation is granted. Deficiencies noted during subsequent biennial onsite assessments of an accredited contractor should be corrected within 60 days of the close-out meeting. If a contractor disagrees with a part of the assessors' findings, the contractor may request that the Performance Evaluation Program Administrator review and reverse the findings in question. A further appeal may be directed in writing to the Appeals Board if the assessors' findings are upheld. When out-of-calibration apparatus is cited, the apparatus should not be used until corrective action has been completed. Any deficiencies noted for corrective action are reviewed during subsequent onsite visits and technical evaluations.

4.3.6 Monitoring Visits. In addition to regularly scheduled onsite assessments, assessors may be assigned to make monitoring visits at any time during the two-year accreditation period. Monitoring visits may occur for cause or on a random basis. These visits may serve to verify reported changes in the contractor's processing facilities and/or operations. The visits may also explore possible reasons for poor performance in proficiency testing. The scope of a monitoring visit may range from checking a few designated items to making a complete review.

4.4 Granting Accreditation

When the technical evaluation has been completed or at the end of the accreditation period, the Performance Evaluation Program Administrator prepares an administrative report and recommendation for the DOE Headquarters DOELAP Administrator and the Oversight Board. The Board evaluates the report and recommendation and proposes one of two options:

- **Accreditation** - The HQ DOELAP Administrator completes the accreditation process by issuing a certificate of accreditation to the contractor.
- **Remedial Action Required** - The contractor is notified that remedial action is required and of the reason(s) for the remedial action. The contractor must immediately identify and implement a remedial action plan within 45 days of receiving the notification. This plan is sent to the HQ DOELAP Administrator through the DOE field office with a copy to the Performance Evaluation Program Administrator. A contractor may request an Appeals Board review.

Dosimetry systems may be partially accredited if a system is demonstrated to be satisfactory in a particular subset of the DOELAP irradiation categories. If a system has not satisfactorily demonstrated compliance with the test criterion in a particular subset of categories and if a remedial action plan is initiated, the accreditation process may continue in all other categories.

The contractor has the responsibility to inform the Performance Evaluation Program Administrator whenever any changes are made in dosimeters or processing techniques. The contractor must provide evidence supporting a conclusion that the system is technically equivalent to the accredited system. The Performance Evaluation Program Administrator with the Oversight Board's approval makes a determination of technical equivalence. If they decide the

changed dosimeters or techniques are not technically equivalent, the accreditation does not cover the dosimeters or techniques. They must be fully evaluated and/or demonstrate a satisfactory dosimeter performance in accordance with DOELAP requirements before they are covered.

If a change in the type or quality of radiation fields occurs, or is anticipated, the contractor shall inform the Performance Evaluation Program Administrator. The contractor shall also justify either that the existing accreditation is adequate, or that additional accreditation testing is required. The Performance Evaluation Program Administrator will recommend approval or disapproval. The justification with the recommendation is forwarded to the Oversight Board for action. The contractor may request a review of the results by the Appeals Board. If the current dosimetry system is not adequate, the contractor may: (a) apply to accredit either the current system, a new system, or a supplemental system including the new radiation field(s), or (b) obtain dosimetry services from a DOE contractor currently accredited for the radiation field(s) involved.

5. EXCEPTIONS

DOELAP excepts some B-Clause contractors from these requirements. These B-Clause contractors do not perform in-house dosimetry and do not routinely report significant doses received by personnel (e.g., small university contracts). In these cases, the B-Clause contractor may choose to obtain accreditation from either DOELAP or NVLAP. Field offices may apply for additional exceptions to the HQ DOELAP Administrator.

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APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

1. DOE site or facility _____

2. DOE Field Office _____

3. Other DOE facilities using your personnel dosimetry services (specify dosimeter designs and applicable categories required). _____

_____

_____

4. Vendor identification, if outside vendor used:

_____

_____

_____

5. Name of authorized representative of management for DOELAP accreditation

Name _____

Title _____

Department _____

Contractor _____

Address _____
Street or P.O. Box City State Zip Code

Telephone _____

6. List all dosimeters, by name and model number, for which accreditation is sought and place an (x) under each dosimeter listed, opposite the appropriate category (see DOELAP Handbook and DOE Standard for a detailed explanation of each category).

Category		Dosimeter Designation
I.	Low-Energy Photon[a] (High Dose)	
II.	High-Energy Photon[b] (High Dose)	
IIIA.	Low-Energy Photon	
IIIB.	Low-Energy Photon (Plutonium)	
IV.	High-Energy Photon	
VA.	Beta	
VB.	Beta (Uranium)	
VC.	Beta (Special)[c]	
VI.	Neutron[d]	

a. Automatically entered if entered in Category IIIA or IIIB.

b. Automatically entered if entered in Category IV.

c. Please specify whether a high energy beta source ($^{90}Sr/^{90}Y$) or a low energy beta source (^{204}Tl) more nearly approximates the beta spectra of your facility.

d. Please specify one or both of the neutron sources. Use only the source(s) that more closely represent the energy spectra found in the occupational environments covered by your service. If the energy spectra vary significantly, both sources may be necessary.

NOTE: If a dosimeter is entered in two or more single categories (III-VI), it is automatically entered into all of the appropriate mixture categories (VII). A combination dosimeter with physically separate parts should be listed as one dosimeter. A separate neutron dosimeter should be considered part of a general beta-gamma-neutron dosimeter and submitted together with the beta-gamma dosimeter to the neutron/photon mixture categories. The Performance Evaluation Program Administrator will inform you of the required number of dosimeters to be submitted for each of the three irradiation periods.

7. Which of the dosimeters listed in the table above are currently in use? Planned for future use? Under study? (No additional information is required for dosimeters under study.)

8. For each dosimeter listed in the preceding table, describe important design features, including: type of dosimeter material, type of badge or dosimeter holder used, dosimeter placement inside the holder, and type and arrangement of absorbers. Diagrams are helpful. (Proprietary information should not be included.)

9. For each dosimetry system listed in the table, attach a short statement to justify not seeking accreditation in any of the listed categories.

10. For each dosimeter, state whether it is processed in-h a commercial laboratory, or in another government facility.

11. Describe in-house dosimeter processing, including readout apparatus and procedures and protocols for the handling, storage, and preparation of dosimeters. Indicate whether processing is manual or automatic. Indicate procedures that may differ for different categories.

12. If an angular dependence study of dosimeter performance and a determination of the lower limit of detectability have been performed, results should be included with this application. If not, results will be required prior to the granting of accreditation (see DOE Standard for the Performance Testing of Personnel Dosimetry Systems).

13. If field calibrations of dosimeters are used to determine occupational exposures, the dosimeter calibration documentation for each field type should be included with this application.

I hereby authorize this application and attest that all statements made are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

Authorized Representative:

Printed Name _____

Signature _____

Title _____

Date _____

By authorizing this application you affirm that you are aware that if accreditation is granted to your organization, the accreditation applies to dosimetry processing services using the specific dosimeter models/types in the categories requested and using the processing techniques that were used to demonstrate satisfactory performance in accordance with the DOE Standard. You will be expected to use the same dosimeter(s) and techniques in the normal processing activities you perform.

If any changes are made or deviations occur in these dosimeters or techniques, it will be the responsibility of your organization to provide evidence that such changes lead to results that are technically equivalent to the accredited processing activities. Determination of technical equivalence will be made by the DOE Oversight Board.

If the changes or deviations to the dosimeters or processing techniques are not considered to provide results that are technically equivalent, the new dosimeters and/or techniques will not be covered by the accreditation until they have been fully evaluated and/or their performance has been demonstrated in accordance with the DOE Standard.

In authorizing this application you declare that you commit the applicant contractor to:

- Be examined and audited, initially and on a continuing basis during the accreditation period
- Permit the onsite assessors to review and examine records or other documents required by the DOELAP Handbook
- Maintain compliance with applicable handbook criteria
- Participate in proficiency testing programs that may be required for maintaining accreditation.

Field Office Review: (to be completed before application is submitted)

Printed Name _____

Signature _____

Title _____

Date _____

APPENDIX B

CRITERIA FOR ONSITE ASSESSMENT

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CRITERIA FOR ONSITE ASSESSMENT

The site assessors are given considerable latitude in evaluating a contractor's personnel dosimetry program. To help each contractor receive a fair assessment, the assessors are provided with this list of criteria covering the main points of a good program.

General

The contractor shall have the latest versions of the processing protocols, dosimeter specifications, quality assurance manual, and other related documents (equipment manufacturer instructions, etc.) available at the facility. The latest version of these documents must be used in conducting all routine processing.

Personnel

1. The functional organization must be consistent with the current organizational chart for the personnel dosimetry program.
2. The qualifications of the individual who has technical responsibility for the personnel dosimetry program must be consistent with the position description.
3. The individual who has technical responsibility must generally exhibit adequate technical knowledge and management control for personnel dosimetry.
4. The individual who has technical responsibility must ensure all dosimetry data are approved.
5. The qualifications of the individual responsible for personnel dosimetry quality assurance (QA) must be consistent with the position description.
6. The responsibility for maintaining and revising the QA manual must be clearly assigned.
7. All personnel dosimetry program staff members must be familiar with and implement the documented quality control program.
8. Communication between technical and supervisory staff members must be adequate.
9. An independent organizational relationship must exist between dosimeter processing and other contractor activities.
10. A designated individual must exercise the authority to assign processing tasks and to ensure timely dosimeter processing.
11. The responsibility for major equipment maintenance, calibration, and servicing major equipment must be clearly assigned.
12. Assigned staff members must be knowledgeable about dosimeter processing equipment and competent in performing assigned processing tasks.
13. The QA manual must describe practices for ensuring staff member competency.
14. The QA manual must describe the training program to prepare staff members to conduct processing protocols.
15. The QA manual must have provisions for retraining assigned staff members when protocols are revised.
16. The competency of staff members should be verified annually, through one or both of these methods:
    - Observation of the conduct of processing protocols by technically qualified individuals
    - Written examination based on the processing protocols.
17. A record of the dates and findings of competency reviews must be available for review.
18. Specialized skills required to conduct all processing protocols must be documented. The training program for individuals who conduct the protocols must include these skills. In addition, the training must include:
    - A period of close supervision until competency is demonstrated
    - A mechanism to evaluate and inform staff members of the adequacy of their performance in conducting assigned processing protocols
    - A mechanism to retrain periodically and to correct any deficiencies in performance between the retrainings.
19. Agreement between assigned processing responsibilities and the technical areas

addressed in the training program must be apparent.

20. A record of training courses completed by each staff member must be available for review.

Equipment and Facilities

1. A list and description of the facilities and equipment used in all the processing protocols for which accreditation is requested must be available in the laboratory. The list allows the facilities and equipment to be correlated with calibration records.
2. Dosimetry readout equipment appropriate for the dosimetry system must be available.
3. When an annealing oven or furnace is necessary, it must be reserved strictly for dosimeter annealing.
4. There must be a method for securing and maintaining the resources required for the processing activities for which accreditation is requested.
5. Procedures should be established to bring backup equipment into routine service, repair equipment on a rapid-response basis, and/or use the services of another DOELAP-accredited contractor. Such procedures ensure continuity of service when personnel or dosimetry systems fail to perform within the control limits.
6. Dosimetry processing equipment must be identified well enough to permit correlation with calibration records.
7. Adequate controls must be in place to ensure equipment performance at the levels of precision and accuracy the contractor defined in each processing protocol. The operating procedures to be implemented when the equipment fails to meet these criteria must be documented.
8. To help evaluate the stability of equipment performance, records of preventive maintenance and repairs must be available for each piece of processing equipment.
9. Service contracts or an in-house capability to maintain equipment and stock parts must be adequate to ensure continuity of equipment operation.
10. Environmental parameters in the processing facility, including background radiation, must be measured and recorded.
11. Calibration and verification records for major equipment used in dosimetry processing must include
    - Equipment name or description
    - Manufacturer's name
    - Model, style, serial number, or other identifying mark
    - Identification of all equipment variables requiring calibration or verification
    - Range of dose measurements for calibrations
    - Allowable error (taking into consideration instrument tolerance) to coincide with the requirements of each processing protocol
    - Schedule for periodic calibrations, including calibration/verification date
    - Date and result of last calibration/verification, including assessed uncertainty of measurement
    - Identification of staff member or position responsible for equipment calibration, or identity of external service performing calibration
    - Identity of reference standard and how the individual dosimetry data relate to national standards or to nationally accepted measurement systems.
12. The calibration of equipment must be verified at regular intervals. These intervals are determined by equipment type, manufacturing specifications, accumulated stability data, or some other reasonable plan. In all cases, the processor must demonstrate the reliability of the measurements performed.
13. Duties are assigned for all processing equipment maintenance and for routinely verifying all equipment is in proper working order.

Quality Assurance

1. Technicians must be familiar with and implement the documented quality control program.
2. The quality control program must be organized to assess the variability of test results among staff members.
3. The supervisor must examine audit results. Action must be taken to correct any deficiencies.
4. Records of the laboratory's participation in intercomparison programs or external measurement assurance programs must be consistent with practices defined in the QA manual.

5. If processing is conducted in multiple locations within the processor's facility, the processor must perform comparative tests to assess the consistency of dosimetry data.
6. The documented QA system must clearly describe records kept and practices followed. These records and practices must cover the process from the point of dosimeter receipt through to the final delivery of data to the user.
7. Records of any deviation from the use of documented processing procedures, equipment, or facilities must be kept to show no degradation of performance occurred.
8. The QA program must incorporate external checks, including:
   - Processing controls (e.g., light source readings, microprocessor controls)
   - Blind-audit dosimeters
   - Unexposed dosimeters.
9. A comprehensive record of processing activities (i.e., a dated log) must be maintained. This record must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.

Dosimeters

General Criteria

1. Practices for receiving, handling, and storing dosimeters must be consistent with provisions in the QA manual.
2. A positive system for identifying and tracking all dosimeters must be in use.
3. A satisfactory acceptance criterion for all dosimetry material must be established. The criteria must be documented in the QA manual.
4. Sufficient information must be contained in the dosimeter identification code to allow correlation with the record system used in processing.
5. The dosimetry system documentation must include a design specification. The specification must show the minimum and maximum exposure level the dosimeter can record during routine processing.
6. A procedure for checking the proper assembly of dosimeter cards and/or film packets must be documented.
7. Documented procedures must be used to verify:
   - Filter materials are consistent with the dosimeter design
   - Filters are properly placed in dosimeters.
8. A procedure must be established to verify dosimeter holders meet required specifications.
9. The QA manual must document procedures for handling dosimeters before they are issued.
10. Dosimeters placed in service must be checked according to a defined schedule or frequency to ensure all necessary components are in place.
11. A screening procedure must be used to ensure that dosimetry materials (sensitive elements) are consistent with the dosimeter design. The procedure must include phosphor type and sensitivity.
12. The identification system must be adequate to ensure the correct identification of both demountable (nonfixed) and fixed thermoluminescent (TL) elements. The system must also identify the association of each TL element with a position or filter in the dosimeter.
13. The same dosimeter type or model and sensitive elements used during proficiency testing must be used to assess occupational exposures.
14. Information available concerning processed dosimeters should include:
   - Radiation type
   - Dose definition (terminology)
   - Responsibility for handling the dose of record
   - Calibration procedures used in dose determination
   - Quality control
   - Special processing procedures to be used as part of the dosimetry service
   - Directions for handling and using background control dosimeters
   - Identifying anomalies noted during processing.
15. A person must be assigned responsibility for the receipt of in-service and background control dosimeters. There must also be a proced re to cover this. The procedure must include:
   - The individual dosimeter identification, the dosimeter type, and the appropriate processing protocol to be followed
   - Identifying and coding internal and external control dosimeters
   - A mechanism for tracking an individual dosimeter and/or sensitive element through the processing cycle

- A mechanism for identifying dosimeters that have not been returned by clients for processing
- A method for screening dosimeters or TL elements for significant contamination prior to readout
- A method for identifying mishandled background control dosimeters.

16. The location of dosimeters within the laboratory must be documented.
17. Environmental parameters, including background radiation, must be monitored in dosimeter storage areas to ensure adequate storage conditions.

Thermoluminescence Dosimeters (TLDs)

1. Equipment for reading out and annealing TL elements must be appropriate for the system.
2. A written procedure must exist and responsibility must be designated for establishing and checking appropriate instrumentation operating conditions. This check may include the following:
   - Reproducible positioning of the TL element in the reader
   - Stabilization against voltage change or drift in dark current when applicable
   - Reproducible heating cycle that ensures readout of a consistent fraction of relevant stored energy
   - Glow curve output
   - Inert-gas purging
   - Digital readout.
3. A method for removing sensitive elements from the dosimeter case must be documented and implemented. The method must preclude losing information from the sensitive element.
4. The operation and stability of TLD readers must be checked at least daily using preexposed dosimeters or light sources. Records must indicate that no dose measurements are made until equipment conditions have stabilized.
5. Sufficient measurements must have been made to establish the relationship between the TL emission-dose characteristics and the conversion factor. The conversion factor is used to convert instrument reading to dose equivalent.
6. Technicians must understand operating conditions and critical functions of TLD processing equipment, including:
   - Heating/temperature cycle
   - Inert-gas purging
   - Annealing cycle
   - Recognition and resolution of equipment failure.
7. Procedures for loading and unloading the TL reader must be implemented as documented.
8. The processing protocol must include reviewing selected dosimetry data during the readout cycle.
9. Before they are issued, TLDs or phosphors must be subject to an adequate annealing cycle. The annealing cycle must be reproducible regarding time, temperature, cooling rate, humidity, and light.
10. Background readings must be checked according to an established procedure before TLDs are issued.
11. Precautions must be taken to minimize the exposure of light-sensitive TL materials to light.
12. Precautions must be taken to avoid the contamination of TL elements (e.g., by chalk, dust, grease, or any radioactive material).
13. Loading sensitive elements must be carried out in a well-defined order. Loading procedures must prevent confusion in handling visually-similar elements of different TL materials and contamination of TL material in powder form.
14. To prevent damage or unknown exposure during transit, TLDs must be suitably packaged for issue to users.
15. TL material fading under normal conditions must be documented and accounted for over the period of intended use.
16. The TL material for each dosimeter type or model must be capable of withstanding heat treatment required in the dosimetry process.

Film Dosimeters

1. An acceptance procedure must be in place to verify film as received meets the manufacturer's specifications. It must further verify the film's expiration date is beyond the anticipated time of use and processing.
2. Equipment, facilities, and materials must be adequate to support the film processing operations for which accreditation has been requested.
3. Film-processing darkroom(s) must be temperature-controlled and have properly installed safelights. They must either use incandescent lights or be able to demonstrate nonincandescent lights do not affect the dosimeter results.

4. Safelights used in darkrooms must be tested at prescribed intervals. Testing shall measure the fog level of exposed films. Exposure shall be at the normal working distance from the safelights for a period comparable to the maximum processing time.
5. Precautions must be taken to prevent accidentally exposing the films to light while they are being processed.
6. Processing chemicals must be dated and properly stored. A procedure must exist for their disposal when their shelf life expires.
7. Tanks and equipment that hold or are exposed to processing solutions must be chemically inert.
8. The equipment must be capable of measuring film densities equivalent to an optical density of 0.01 to 5. Resolution shall be ±10% or ±0.01 density units, whichever is greater, and the equipment must be adequate to support the workload.
9. Records must demonstrate the accuracy and reliability of all instruments used to determine the gross density of specimen and control films.
    - Densitometer performance must be checked for consistency before use.
    - Densitometers must be calibrated at the most frequent of these three intervals:
        - As the manufacturer recommends
        - Biannually
        - As directed in the processing protocol.
10. Films must be removed in the darkroom and loaded in identifiable order in film racks for processing.
11. Through quality control films, the dose density characteristics of each film emulsion batch must be established. A known relationship with the master algorithm for the dosimeter model must also be established.
12. Quality control films of the same emulsion lot must be included in each processed batch. The quality control films should be exposed to known doses that adequately check the response curve of the dosimeter type. They must be positioned at the beginning and end of each processing batch and at intervals as defined in the processing protocol.
13. At least two unexposed films of the same emulsion lot must be included in each processed batch.
14. Processing control films must be verified as meeting control limits before routine processing activities are initiated.
15. As a minimum, the contractor must follow the film manufacturer's recommendations when adopting chemistry and processing conditions in the processing protocols.
16. Before it is issued, film must be stored unopened. The storage location must be cool, dry, free from chemical vapors or other deleterious agents, and have low background radiation.
17. Film must be current. It must be stored so as to reduce buildup of density due to natural background radiation and/or deterioration with age.
18. Before film is issued, its emulsion lot number must be noted and each lot must be tested. Testing shall check that the fog level, dose density, and spectral characteristics are satisfactory.
19. To prevent damage or unknown exposure during transit, film dosimeters must be suitably packaged for issue to users.
20. Records must show that temperatures and times for development, stop bath, fixing, washing, and drying are reproducible and consistent with processing protocols.
21. Developer/fixer solutions must be kept covered to reduce oxidation and exclude contamination.
22. During development, the developing solution must be agitated to provide for the uniform development of all film.
23. Procedures must be documented and followed to allow the appropriate time lapse between preparing developer and fixer solutions and using them. They must also document and follow the time lapse for discarding or replenishing these solutions according to how long they are used or how many films are processed.
24. If a stop bath is used, procedures must be documented and followed for using and renewing it.
25. Fixing procedures must be documented. They shall be implemented according to the manufacturer's recommendations.
26. Washing procedures after fixing must be as documented.
27. The temperature difference in adjacent processing solutions must not exceed 3°C.
28. Records must indicate the apparatus used to dry film does not exceed the appropriate drying temperatures. Drying temperatures must be documented in the processing protocol.

29. After processing, films must be stored so they may be retrieved without damage to the emulsion.
30. Films must be examined for nonuniform blackening. A special measurement procedure must be defined for those showing significant nonuniform blackening.
31. All measurements made must be recorded with film identification codes.
32. Track detectors must be evaluated using optical or counting equipment appropriate for the anticipated macro- or microscopic track dimension.

Calibration

1. Calibration and verification practices for dosimetry systems must be outlined in the QA manual. The manual must identify the calibration services, reference materials, and measurement assurance programs used.
2. Dosimetry systems must be calibrated to known doses from radioactive sources or radiation-generating machines. The calibration facility radiation fields must be measured with calibrated instruments. Instrument calibrations must be traceable to national standards or based on the measurement of activity of a source. In the latter case, the source must be traceable to primary radiation standards. Care must be taken to maintain a standard source geometry.
3. Calibration protocols used must be appropriate for the sources of radiation at the facility and the potential exposure levels.
4. The energy response of each type or model of dosimeter must be characterized by calibrating each model for all appropriate radiation categories. The dosimeter response must be determined over the exposure range for which it is to be used.

Processing

1. The processing protocol must be documented in sufficient detail that it can be followed by a competent technician.
2. All processing personnel must adhere to processing procedures defined in processing protocols.
3. A comprehensive record of processing activities (i.e., a dated log) must be maintained. The log must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.
4. When any deviation from using documented processing procedures, equipment, or facilities occurs, records must show performance remained satisfactory during the period in which the deviation occurred.
5. The individual technically responsible for dosimetry processing or his/her assigned representative must give final approval of dosimetry data. This person must also make decisions regarding questionable data.
6. The algorithm must be satisfactorily documented to indicate its validity for dose interpretation. Documentation must indicate:
   - The algorithm was created and tested using fundamental data that are retrievable.
   - The uncertainty analysis of the algorithm characterizes the precision and accuracy of the dose interpretation to the dosimeter.
   - Process controls were considered and documented when the algorithm was developed.
   - The attributes and limitations of the algorithm are documented.
7. Computational models or algorithms for calculating dose from raw data must be adequate for the processor's dosimetry system.
8. All processing protocols must be audited to ensure no degradation of performance occurs.
9. Each processing protocol must provide for interspersing quality control dosimeters. These dosimeters must have a predetermined relationship to the primary calibration dosimeters as follows:
   - Suitable sources must be used to irradiate the quality control dosimeters.
   - Records must indicate good reproducibility for the irradiation method.
   - Evaluation of the quality control data must be outside the control of the processing technician.
   - The contractor must have determined how frequently blank and quality control dosimeters shall be used. This determination must be based upon the total number of dosimeters processed, equipment stability, the type of quality control checks used, or other suitable means.
10. The dose of quality control dosimeters must be determined either from measurements using a transfer-standard quality instrument or by

calibration from a source of known activity. Instrument calibration and the activity of the source must be directly traceable to primary standards.

11. A procedure must exist for a detailed review of data produced between the last successful quality control dosimeter and the first quality control dosimeter failing to meet control limits.
12. Dose measurements must be identified and recorded at the time of measurement.
13. The useful dose range for the dosimetry system must be established and documented in each radiation category of interest.
14. Control limits to accept dose measurement data from in-service dosimeters must be defined and implemented.
15. The technical director or a designee must review dosimeter data for anomalies before reporting the dose.

Reports

1. The QA manual must outline practices for handling and resolving contested dosimetry data and test reports.
2. The dose report must include:
   - Name and address of processor, if different from contractor
   - Name of contractor
   - Pertinent dates and the identification of dosimeters, including processor and contractor identification codes, if appropriate
   - An explanation of any deviation from routine processing procedures if the deviation could affect the reported dose
   - The signature of or a reference to the person having technical responsibility.

Testing

1. Protocols for proficiency testing in accordance with the DOE Standard must be defined. They must be consistent with routine processing procedures.
2. A written test plan for each radiation category for which accreditation is sought must be available to the processing staff.

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ORC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 26, 1996

MEMORANDUM TO: Frank A. Wenslawski, Chief
Materials Branch
Walnut Creek Field Office, RIV

FROM: Josephine Piccone, Chief
Operations Branch
Division of Industrial and Medical
Nuclear Safety, NMSS

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS

I am responding to your technical assistance request (TAR) dated September 27, 1996, regarding the request by EPA, Las Vegas, to continue the exemption from 10 CFR 20.1501(c) that is in their current license. The license is due for renewal, and WCFO questioned whether the exemption should be carried into the new license. Under the exemption, EPA, Las Vegas, would use personnel dosimetry accredited under the Department of Energy's (DOE) DOELAP program, rather than the NVLAP program, as required by 10 CFR 20.1501(c).

In Headquarter's response to the original TAR, dated July 10, 1996, on the same subject, we indicated that EPA should be granted the exemption in their new license only if they provided adequate justifications for such an action. One of the justifications that would be considered acceptable was inordinately high financial burdens involved in obtaining NVLAP accreditation.

EPA, Las Vegas, has subsequently provided additional material in support of their exemption request. In that material, they indicated that the dosimetry is used predominantly in association with DOE activities. EPA also noted that providing external dosimetry for DOE in the areas around the Nevada Test Site, including both environmental and personnel TLDs, requires DOELAP accreditation, and that the performance testing criteria for DOELAP exceed those of NVLAP, and therefore accreditation under DOELAP is preferable for maintaining a higher standard of quality assurance and control. In addition, EPA indicated that obtaining accreditation under NVLAP would cost them an estimated $10,000.

The unique combination of circumstances in this case, namely the fact that the licensee is already accredited under DOELAP, the high cost of the changes needed for accreditation under NVLAP as well as the accreditation fees, and the close association with DOE operations at the Nevada Testing Site, make granting the exemption the most appropriate course of action at this time. It is therefore suggested that the exemption from 10 CFR 20.1501(c) be incorporated into the new license.

Attachment: TAR dtd 9/27/96

Contact: Sami Sherbini, NMSS
(301) 415-7902

Beth - another copy
Jan

DISTRIBUTION: (IMNS 5575) - EPA, Las Vegas/dtd 11/26/96

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G:\IMNS5575.SXS *See previous concurrence

OFC	*IMOB		*IMOB		IMOB							
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

IMOB

September 27, 1996

MEMORANDUM TO: Donald A. Cool, Director
Division of Industrial and Medical Nuclear Safety, NMSS

FROM: Frank A. Wenslawski, Chief
Materials Branch
Frank Wenslawski

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS
CONTROL 571951

This Technical Assistance Request (TAR) was originally submitted on July 10, 1996. The issue was whether an exemption from what is now 10 CFR 20.1501(c) can be continued when the license is renewed (the license is in timely renewal status).
License Condition 25. currently allows the licensee to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

In your response of September 4, 1996, you indicated that the exemption should not be renewed unless the licensee provides a sufficiently strong reason for continuing the exemption. Reasons cited for possible continuation of the exemption included requirements that the licensee be DOELAP accredited or inordinately high financial burdens involved in obtaining NVLAP accreditation. You also stated that the DOELAP accreditation would be recognized until it expires, and then NVLAP accreditation should have been obtained.

Upon receipt of your memorandum, Beth Prange of my staff contacted the licensee to discuss your concerns, as stated in the TAR response. To document the telephone conversation and to formally forward your concerns, a letter was forwarded to the licensee on September 12, 1996. A copy of that letter is enclosed with this TAR.

In response to the September 12, 1996 letter, the licensee submitted the enclosed reply dated September 19, 1996. That document indicates that EPA Las Vegas is constrained to be DOELAP accredited by an Interagency Agreement. It also states that the anticipated costs to become NVLAP certified are on the order of $10,000.00. Further, it is their contention that the DOELAP criteria are more stringent than those of NVLAP. The NVLAP accreditation certificate supplied with the response indicates an expiration date of November 1, 1996.

The licensee provided names and telephone numbers of technical staff who can answer questions regarding the DOELAP accreditation program. We do not object to you contacting them directly to discuss these matters, although we would appreciate being kept informed.

We are asking you to reconsider their original exemption request, in light of the additional information submitted. We recommend that the exemption be renewed. If this is not possible, please provide the reasoning.

If further information is required, contact Beth Prange at (510) 975-0250, or contact the licensee representatives directly.

Enclosures:

TAR Form dated September 27, 1996
Letter dated September 19, 1996
Letter dated September 12, 1996
Memorandum dated September 4, 1996
Memorandum dated July 10, 1996
TAR Form dated July 9, 1996
Letter dated July 3, 1996
Handbook for the DOELAP for Personnel Dosimetry Systems
DOE Standard for the Performance Testing of Personnel Dosimetry Systems
Amendment No. 22 to License No. 27-05861-02

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: September 27, 1996

Mail or E-Mail to: Donald A. Cool, Mail Stop: TWFN 8F5 If E-mail, cc: DAC
Division of Industrial and Medical Nuclear Safety, NMSS

From: Frank A. Wenslawski (FAW) Region IV, WCFO
Chief, Materials Branch

Licensee: EPA, Las Vegas License No.: 27-05861-02

Control No. 571951

Letters dated: September 12 and 19, 1996, enclosed

☐ Problem/Issue: The licensee requests renewal of an exemption from what is now 10 CFR 20.1501(c) to allow them to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP). They have submitted information to demonstrate that they are required to maintain DOELAP accreditation, and that it would involve a significant financial burden to become NVLAP certified.

☐ Action Required: Reconsider the licensee's request (originally submitted July 3, 1996) and determine whether the exemption can be continued in light of additional information. If not, specify the reasoning.

Recommended Action (with revisions): X Approve

Headquarter Reviewer: (For HQ use)
Regional Reviewer: Beth Prange (BAP1)
Reviewer Code: W1
Reviewer Phone No.: (510) 975-0250 FAX No.: (510) 975-0381
Request Needed by: 10/21/96

Form TAR-10
9/93

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

September 19, 1996

OFFICE OF
RESEARCH AND DEVELOPMENT

U.S. Nuclear Regulatory Commission
Region IV
ATTN: Beth Prange
Sr. Health Physicist (Licensing)
Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

Dear Ms. Prange:

This is in response to your letter dated September 12, 1996 (refer to mail control number 57951, regarding exemption request, dated July 3, 1996), which requested submission of the reasons our exemption request should be continued.

The Office of Radiation and Indoor Air, Radiation Sciences Laboratory in Las Vegas (ORIA, RSL - LV) processes dosimeters predominantly associated with U.S. Department of Energy (DOE) activities. RSL - LV processes dosimeters for eight radiation workers (covered under NRC license), seven for the ORIA - LV and one for the National Exposure Research Laboratory in Las Vegas (NERL - LV); for forty-five occupational workers, eleven for NERL - LV and thirty-four for ORIA - LV. In addition, we act as a back-up to the Nevada Test Site (NTS) External Dosimetry Personnel Monitoring Program, which includes the Federal Radiological Monitoring and Assessment Center (FRMAC) and other radiological emergency response activities.

Providing external dosimetry for DOE in the areas around the NTS, including both environmental and personnel TLDs, requires Department of Energy Laboratory Accreditation Program (DOELAP) accreditation. The financial burden we would incur if required to apply for National Voluntary Laboratory Accreditation Program (NVLAP) accreditation and associated fees would be excessive, amounting to approximately $10,000.00 for the application plus personnel time.

Currently we are DOELAP accredited in categories I, II, IIIA, IV, and VII. The performance testing criteria for DOELAP exceed those of NVLAP for all categories except categories I and II, for which the criteria are the same. Specifically, for both NVLAP and DOELAP the tolerance level (L) is the same (L = 0.3) for categories I and II (that is, category I, accidents, low-energy photon, and category II, accidents, high-energy photons). But for categories IIIA, IV and VII (Mixture Categories III + IV) , the DOE criteria are more strict.

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Specifically, L for NVLAP is 0.5, whereas for DOELAP it is 0.3. The more restrictive performance testing necessary to obtain DOELAP accreditation is preferable to maintain a higher standard of quality assurance and control. RSL - LV does not process dosimeters specifically for beta or neutrons.

In summary, our program would be best served from a financial and quality assurance point of view if we were to receive an exemption.

If you or other NRC staff have technical questions, we would be pleased to host a telephone conference call at which our staff would answer questions. This might facilitate your review of this request, and avoid the lost time associated with exchanging letters.

Enclosed is the copy of our DOE interagency agreement you requested. If you require further clarification in this matter, please do not hesitate to contact Anita Mullen at (702) 798-2597, or Christopher Fontana at (702) 798-2429.

Sincerely,

Wayne N Marchant

Wayne N. Marchant
Director
Characterization Research Division

Enclosure

wo/enclosure
cc: Loyd Carroll
Chrisitian Daughton
Anita Mullen
Paul Weeden

DOELAP

United States Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems

Certificate of Accreditation

U.S. Environmental Protection Agency

is recognized for demonstrating compliance with DOE performance testing for personnel dosimetry systems. Accreditation is limited for the dosimetry systems and irradiation categories specified in the conditions of accreditation.

November 1, 2994

Effective date

Robert M Lasseter

DOE Laboratory Accreditation Program Administrator

CONDITIONS OF DOELAP ACCREDITATION

U. S. Environmental Protection Agency

Environmental Monitoring Systems Laboratory - Las Vegas

Effective until November 1, 1996, the whole body personnel dosimetry systems described below, used at the Environmental Monitoring Systems Laboratory - Las Vegas (USEPA), are granted DOELAP accreditation:

Dosimeter Identification:

Panasonic UD-802AT TLD.

Reader System:

Panasonic Model UD-710A Automatic Reader

DOELAP Categories: Panasonic UD-802

- I. Low-Energy Photons, High Dose Levels
- II. High-Energy Photons, High Dose Levels
- IIIA. Low-Energy Photons, Filtered X-Rays
- IV. High-Energy Photons
- VII. Mixture Categories:
  - III + IV

Accreditation is for these dosimeters and reader systems only and is contingent upon maintaining dosimetry practices that are consistent with the methodologies used during DOELAP performance testing and the onsite assessment. Re-accreditation of your dosimetry system will be necessary every two years as required by DOE 5480.15 and as discussed in the DOELAP Handbook (DOE/EH-0026).

57195

DE-AIO8-96NV11969
INTERAGENCY AGREEMENT (IA) BETWEEN
THE U.S. DEPARTMENT OF ENERGY
AND
THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FUNDS-OUT IA

This IA consists of the following:

IA Face Page

Article	I	Purpose
Article	II	Scope of Work
Article	III	Costs, Support Level, Budgeting, and Finance
Article	IV	Deliverables/Reports
Article	V	Duration of Agreement
Article	VI	Program Officers
Article	VII	Obligation of Funds
Article	VIII	Payment
Article	IX	Classification
Article	X	Property Fire Protection
Article	XI	Documents Attached and Part of this Agreement
Article	XII	Documents Incorporated by Reference

(57195)

I. PURPOSE

The purpose of this Agreement is to define respective responsibilities of the parties. This Agreement will be administered on behalf of the U.S. Department of Energy (DOE) by the Nevada Operations Office (DOE/NV), or any representative or representatives designated by the Contracting Officer (see Item 6 of Face Page). This Agreement will be administered on behalf of the U.S. Environmental Protection Agency by the Office of Radiation and Indoor Air (EPA/ORIA)(see Item 7 of Face Page). The EPA/ORIA provides radiological and non-radiological sampling and analytical capabilities required for compliance with DOE requirements, as well as Clean Air Act/National Emission Standards for Hazardous Air Pollutants (NESHAP, 40 CFR 61) and Clean Water Act (CWA, 40 CFR 161).

II. SCOPE OF WORK

a. General

This Agreement recognizes that both the EPA/ORIA and DOE have statutory responsibilities which are not limited or affected by this Agreement. This agreement covers those services EPA/ORIA will perform in connection with the DOE Stockpile Stewardship and Test Readiness Program and other DOE/NV activities, including providing assistance in DOE Nevada Test Site special projects, emergency preparedness (CONUS and OCONUS), and training. The scope of such services to be performed will be as requested by the DOE and within the limitation of the particular DOE program funds in fulfillment of DOE's statutory responsibilities and as agreed to by EPA/ORIA, within its capabilities and statutory limitations.

EPA/ORIA will provide radiological and non-radiological sampling capabilities for NTS and other facilities managed by DOE/NV. Sampling will consist of sampling stations at nearby cities and rural locations in accordance with appropriate DOE/NV guidelines, NESHAP (40 CFR 61), and CWA (40 CFR 161). Sampling will include, but not be limited to, the following: Air Particulates, Tritium-in-Air, Ground Water Monitoring, Milk, Pressurized Ion Chambers (PIC), Thermoluminescent Dosimetry (TLD). The EPA/ORIA is also to produce reports of the data available from previous historical sampling regimens as well as producing sampling report data for the DOE/NV Annual Site Environmental Report (ASER) each year. The EPA/ORIA will also provide similar data reports to support the NESHAP Annual Report. The EPA/ORIA will also provide "Down-Hole" sampling capabilities to the On-Site Radiological Environmental Monitoring Plan. The EPA/ORIA will provide emergency/accident sampling capabilities for DOE/NV as well as cross-check Quality Assurance and Quality Control programs as requested. The EPA/ORIA will act as the

backup dosimetry laboratory for the DOE prime contract dosimetry laboratory in emergency situations. The EPA/ORIA will also serve to provide environmental analytical/management services as requested by DOE/NV.

b. Radiological Environmental Monitoring Program

The EPA/ORIA will provide radiological environmental monitoring programs which include activities requested by DOE such as Stockpile Stewardship and Test Readiness Support, Special NTS Project Support, long term hydrological monitoring, dosimetry, and laboratory capabilities. EPA/ORIA will provide a panel member to the Experiment Controller. Programs will be staffed by qualified scientists and supporting personnel. Programs will be conducted in accordance with applicable federal regulations, DOE Orders, and industry standards.

c. Non-Radiological Monitoring

The EPA/ORIA will carry out public notification and will assist in evacuation programs as required by nonradiological effects of DOE/NV testing programs at any location. These programs will be with specific procedures mutually agreed upon by the EPA/ORIA, DOE/NV, and in consent with state officials. EPA/ORIA will provide a safety panel member to the Operations Controller at the Hazmat Spill Center (HSC) for project support. EPA/ORIA will provide nonradiological monitoring support at the HSC. Funding is provided by users utilizing the HSC and is separate from this agreement.

d. Quality Assurance Program

(1) The EPA/ORIA will develop, implement, and maintain a comprehensive Quality Assurance Program (QAP) and will comply with all applicable policies, regulations, requirements, and standards of the DOE as agreed appropriate by the DOE and EPA/ORIA, provided they do not conflict with EPA/ORIA regulations and statutory requirements. The EPA/ORIA's QAP will be structured in a manner to provide overall quality assurance (QA) policies and requirements for the work performed on the IA. The EPA/ORIA's overall QAP is auditable by the DOE/NV.

(2) For all work under this IA, the EPA/ORIA will include in all of its contracts, subcontracts, and consulting agreements, the substance of this QA provision, except for items and activities determined inappropriate by the EPA/ORIA.

e. Community Technical Representative Program

The EPA/ORIA will provide a comprehensive program designed to provide information and assistance to individual citizens, organizations, and local government agencies in communities near the NTS. The program will enhance communications with the public through hiring and training of local residents as Community Technical Representatives (CTR) or Alternate Community Technical Representatives (ACTR) and through developing and maintaining contacts and communications with community leaders and others. The EPA/ORIA will schedule, coordinate, and participate in public education forums as requested or required to maintain a viable program and assist in the ongoing training program for the CTRs and ACTRs. Data collection and analysis procedures will be provided, as well as interpretation and reporting of the data.

III. COSTS, BUDGETING, AND FINANCE

a. Costs

The total estimated cost for accomplishing the IA Statement of Work requirements for five years is as follows:

Direct and Indirect Costs	$15,000,000
Capital Equipment	-0-
Total	$15,000,000

b. Support Level

EPA shall authorize a maximum of 62 full time equivalent positions (FTE's) in support of the DOE programs. However, due to budget constraints placed on DOE it is understood that all FTE's will not necessarily be funded.

c. Work Plan and Budget

The parties will agree annually as to the scope of work to be performed during the period covered by the Agreement and costs thereof and the amount agreed to will be set forth in a modification to this Agreement. EPA/ORIA will provide a management

plan with appropriate budget estimates in sufficient time to be incorporated in DOE/NV annual budget requests.

d. Cost Reporting

EPA/ORIA will submit to DOE/NV monthly reports of the costs incurred in the performance of the work hereunder, by COB on the fourth workday following the end of the reporting month. Such reports will indicate accrued costs incurred for each DOE Budget and Reporting Classification or other similar cost category. Both current month and fiscal year-to-date cumulative costs will be reported on forms supplied by DOE/NV. Since EPA/ORIA accounting is obligation-expenditure (as opposed to accrued cost) based, obligations for all payroll and related costs and for transactions of less than $10K each for obligations falling under other OMB Object Classifications are considered for this purpose to be costs incurred. Nonpayroll obligations greater than $10K are not to be reported as costs until the goods/services in question are actually received (this does not affect billings--see paragraph d. below). A listing of obligations thus deferred (uncosted obligations) will be attached to each monthly cost report. Allocations of overhead are also to be included in the monthly costs reported. These overhead costs will be allocated to each of the costs categories specified above.

e. Cost Reimbursement

EPA/ORIA will be reimbursed monthly for obligations incurred, as required by EPA/ORIA Headquarters policy. Reimbursements will be accomplished via the Department of Treasury On-line Payment and Collection System (OPAC). Differences (both increases and decreases) between obligations and related actual expenditures will be included in the monthly billing/collection process as they become known. Amounts billed will be segregated into two main categories, direct and indirect, with standard OMB Object Classifications reported within each.

f. Cost and Commitment Limitations

The tasks under this IA are funded from various DOE program resources. This makes it necessary to require cost and commitment limitations (ceilings) for each program resource. A "Cost and Commitment Limitations Schedule" will be included as part of each IA modification that obligates or deobligates funds. The individual "Current Cost and Commitment Ceiling" amounts identified in that schedule cannot be exceeded. The EPA/ORIA will monitor costs incurred and commitments for each individual program resource and notify the DOE/NV Contracting Officer and the Resources Management Division in writing whenever current ceiling amounts are projected to be exceeded or substantially underrun. DOE/NV will then either revise

the scope of work under the IA or adjust the various funding levels. Reimbursement of costs incurred will be limited to the "Current Cost and Commitment Ceiling" specifically identified in the IA.

IV. Deliverables/Reports

Participation in formal mid-year and year end budget/schedule briefings
Monthly Cost Reports
Annual Budget Estimate
Contribution to Annual Environmental Report
Contribution to NESHAP Annual Report
Interim Test Reports
Monthly Performance Measurement System Report
Monthly Project Tracking System Report
Such other reports as may be required from time to time

The performing agency will deliver three copies of all reports to the DOE/NV Program Officer at the address shown, see Block 6, Face Page.

V. Duration of Agreement

See Block 4, Face Page.

VI. Program Officers

DOE and performing agency--see Blocks 6 and 7, Face Page.

VII. Obligation of Funds

The total amount presently obligated by the DOE/NV is $522,163.

No other agency has obligated funds under this Agreement.

VIII. Payment

Reimbursement will be accomplished via the Department of Treasury On-Line Payment and Collection System (OPAC). Monthly cost reports will include the following information:

A. DOE Accounting Appropriation Data, see Block 5(a), Face Page.

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21, P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $522,163. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

APPENDIX A
STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT
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APPENDIX A

STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT

1. Definitions. For purposes of this Agreement, "DOE" means the United States Department of Energy or any duly authorized representative thereof, and "Agency" means the performing agency stated in the Agreement of any duly authorized representative thereof.

2. Cost Chargeable to DOE Funds. Direct costs are the costs that can be directly identified with and charged to the work under the Agreement and within the limitations set forth below. Examples of such costs are salaries, technical services, materials, travel and transportation, communications, and any facilities and equipment expressly approved for purchase under the Interagency Agreement.

   a. Foreign travel costs are allowable only when approved by DOE.

   b. Reimbursement for expenditures at technical meetings and seminars at which attendance is not required by DOE, will not be allowable without prior written approval of the DOE Contracting Officer.

3. Financing. DOE will finance programs on a reimbursable basis when acceptable to the other agency. If the reimbursable basis is not acceptable, however, then DOE will finance the work by a Consolidated Working Fund Advance, preferably on a quarterly basis, or by an appropriation transfer or transfer appropriation. DOE will reimburse or will make available, in advance, the amount specified in the Interagency Agreement incorporating these general provisions. Requests for funds will show separately the amount required for (a) operating costs, (b) capital equipment (as defined in 9 below), (c) acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

   a. Vouchers for payment will be submitted on the agreed upon form.

   b. Any funds advanced which are expected to remain beyond the original period of performance for a program/project which is incomplete, of for which there is an increased scope of work, will remain available to the Agency if the IA is amended by the DOE to extend the period of performance for the research program/project or any other work beyond the original completion date. Request for such time extensions should be made to the DOE by the Agency at least 30 calendar days prior to the end of the performance period.

c. Any advanced funds remaining for a continuing research project or any other work remain available for the entire performance period of the project, unless there is a date specified as a required completion date after which no further funds will be expended.

d. Any advanced funds remaining after the completion of a research program/project will be reimbursed to the DOE.

4. Notice of Costs Approaching Total Estimated Costs. Whenever the Agency has reason to believe that the total cost of the work under this Agreement will be substantially greater or less than the presently estimated cost of the work, the Agency will promptly notify the DOE in writing. The Agency will also notify the DOE, in writing, when the aggregate of costs incurred and outstanding commitments allowable under this Agreement is equal to 90 percent (or such other percentage as the DOE may from time to time establish by notice to the Agency) of the presently estimated total costs under this Agreement. When the costs incurred and outstanding commitments equal 100 percent of such estimated total costs, the Agency will make no further commitments or expenditures (except to meet existing commitments) and will be excused from further performance of the work unless and until the DOE will increase the total estimated costs to be incurred with respect to this Agreement.

5. Excess Funds. The Agency will take prompt action to return to the DOE any funds determined to be excess to the work during the performance of the work and any unobligated funds after the completion of the Agreement or as of September 30 each year unless the Agreement has been extended and any unused balances have been carried forward in the extension. In a joint venture project where the performing Agency deposits the advance in any annual consolidated working fund, any unobligated balances will be returned to the DOE before the cutoff date at the close of each fiscal year.

6. Financial Reports. The Agency will furnish the DOE, not later than four working days after the close of each reporting period, monthly or other periodic cost or financial reports in such form and details as may be required by the DOE. Any costs incurred for capital equipment or other assets will be supported by a list showing the description, make, any serial number, and the cost of each item acquired.

7. Accounting Records. The Agency will accumulate and account for obligations and costs incurred in connection with the work being performed under this Agreement in such form and detail as may be required by the DOE.

8. Termination. Either party may terminate this Agreement upon 30 calendar days written notice of such termination addressed to the other party. In the event of such termination, the Agency will be reimbursed, to the extent permitted, for obligations actually incurred to the effective date of termination and for commitments extending beyond the effective date of

termination to a date not later than the date upon which the Agreement would have expired if not terminated under this paragraph, which the Agency, in the exercise of due diligence, is unable to cancel. Payments under this Agreement, including payments under this article, will not exceed the ceiling amount elsewhere specified in the Agreement.

9. Capital Equipment

a. "Capital Equipment" means each item of equipment which is expected to have an extended period of service, generally two years or more, and has sufficient monetary value, generally of $5,000 or more, to justify continuing accounting records for the item.

b. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the procurement or fabrication of capital equipment.

c. If capital equipment is purchased or otherwise acquired pursuant to an authorization under Paragraph (b) above, except as may be otherwise agreed by the DOE and the Agency:

(1) the title thereto will vest in the DOE;

(2) the Agency will be responsible for the maintenance and safeguarding thereof; and

(3) the Agency will maintain a record in such a manner as to ensure adequate control and accounting satisfactory to the DOE, of capital equipment procured or fabricated.

10. Real Property and Facilities

a. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

b. If the Agency acquires or condemns any real property or any facility or acquires, constructs, or expands any plant or facility pursuant to an authorization under (a) above, except as may be otherwise agreed by the DOE and the Agency:

(1) the title thereto will vest in the DOE, and property accountability and control will become the responsibility of DOE;

(2) the Agency will be responsible for the maintenance and safeguarding thereof; and

(3) the Agency will maintain a record thereof in such a manner as to ensure adequate control and accounting satisfactory to the DOE.

11. Patents. It is understood and agreed by DOE and the Agency that the patent policy to be employed in any particular undertaking under this Agreement between the parties, which includes research, development, or demonstration work and is supported by DOE funding, will be set forth in Appendix B.

12. Security of Restricted Data

a. Contracting Agency's duty to safeguard Restricted Data, Formerly Restricted Data, and other classified information. The Agency will, in accordance with DOE security regulations and requirements, be responsible for safeguarding Restricted Data, Formerly Restricted Data, and other classified information and protecting against sabotage, espionage, loss and theft, the classified documents and material in the Agency's possession in connection with the performance of work under this Agreement. Except as otherwise expressly provided in the Agreement, the Agency will upon completion or termination of this Agreement, transmit to DOE any classified matter in the possession of the Agency or any person under the Agency's control in connection with performance of this Agreement. If retention by the Agency of any classified matter is required after the completion or termination of the Agreement and such retention is approved by the DOE, the Agency will complete a certificate of possession to be furnished to DOE specifying the classified matter to be retained. The certification will identify the items and types or categories of matter retained, the conditions governing the retention of the matter and the period of retention, if known. If the retention is approved by the DOE, the security provisions of the Agreement will continue to be applicable to the matter retained.

b. Regulations. The EPA/ORIA will furnish to the DOE/NV Safeguards and Security Division copies of its periodic inspection reports or periodic memoranda covering the DOE/NV classified interest, citing that a satisfactory survey was conducted.

c. Definition of Restricted Data. The term "Restricted Data," as used in this clause, means all data concerning: (1) design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but will not include data declassified or removed from the restricted data category pursuant to Section 142 of the Atomic Energy Act of 1954.

d. Definition of Formerly Restricted Data. The term "Formerly Restricted Data," as used in this clause, means all data removed from the Restricted Data category under Section 142d of the Atomic Energy Act of 1954, as amended.

e. Security Clearance of Personnel. The Agency will not permit any individual to have access to Restricted Data, Formerly Restricted Data, or other classified information, except in accordance with the Atomic Energy Act of 1954, as amended, and the DOE's regulations or requirements applicable to the particular type or category of classified information to which access is required.

f. Criminal Liability. It is understood that disclosures of Restricted Data, Formerly Restricted Data, or other classified information relating to the work or services ordered hereunder to any person not entitled to receive it, or failure to safeguard any Restricted Data, Formerly Restricted Data, or any other classified matter they control in connection with work under this Agreement, may subject any representatives of the Agency, its agents, employees, or subcontractors to criminal liability under the laws of the United States. (See the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.; 18 U.S.C. 793 and 794; and Executive Order 12356.)

g. Contracts and Purchase Orders. Except as otherwise authorized in writing by DOE, the Agency will insert provisions similar to the foregoing in all applicable contracts and purchase orders under this Agreement.

h. Security Requirements for Proprietary Energy Data. The Agency will safeguard DOE official use information, or other proprietary or sensitive data (including material relating to patents), from unauthorized access, disclosure, modification, or destruction in accordance with applicable DOE security regulations and applicable orders and directives.

I. Computer Security Requirements. In the event this Agreement involves utilization of a DOE computer system, the Agency will establish administrative, technical, and physical security procedures in accordance with applicable DOE regulations, to ensure against access to DOE information to individuals not formally authorized by the DOE to possess such information.

13. Classification. The classification function under this IA will be performed by the Agency in accordance with applicable DOE regulations, orders, directives, and guidance.

a. All documents and material originated or generated by the Agency concerning potentially classified subject areas will receive appropriate classification review by the Agency. Classification determinations will be based upon classification guidance furnished by the DOE.

b. Every contract, subcontract, and purchase order issued hereunder involving the origination or generation of classified documents or material, will include a provision to

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21, P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $97,233. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

18. Transition From Former Agreement.

a. Agreement No. DE-AIO8-96NV11969 effective September 1, 1996, supersedes Agreement No.DE-AI08-91NV10963.

b. On and after September 1, 1996, all rights and obligations of the parties with respect to work described herein will be governed by the provisions of Agreement No. DE-AIO8-96NV11969.

c. The rights and obligations of the parties which have been incurred or which have accrued or matured under the provisions of Agreement No. DE-AI08-91NV10963 on or prior to September 1, 1996, will in nowise be impaired, limited, enlarged, or affected by reason of the provisions of this Agreement.

d. All materials, tools, machinery, equipment, supplies, and other property; all drawings, designs, specifications, and other engineering, technical, scientific, operating data, and records furnished to or acquired or generated by the Agency in connection with work under Agreement No. DE-AI08-91NV10963, to the extent that they are in the custody or possession of the Agency on the effective date of this Agreement, will remain in the custody or possession of the Agency for use in connection with the work under this Agreement, unless otherwise directed by the Contracting Officer.

e. All purchase orders, subcontracts, leases, licenses, permits, and other contractual commitments with third parties entered into pursuant to Agreement No. DE-AI08-91NV10963, and outstanding on September 1, 1996, will continue in effect for use in connection with the work to be performed under this Agreement unless otherwise directed by the Contracting Officer, and the reimbursement of costs incurred thereunder after September 1, 1996, will be subject to the provisions of this Agreement.

f. Subject to the foregoing paragraphs, all of the rights and obligations of the parties under Agreement No.DE-AI08-91NV10963, are assigned and transferred from said Agreement No. DE-AI08-91NV10963 to this Agreement No. DE-AIO8-96NV11969 and made a part hereof by this reference as though full set out herein. Subject to the other provisions of this Agreement, any costs associated with the transition from Agreement No. DE-AI08-91NV10963 to Agreement No. DE-AIO8-96NV11969 will be allowable cost.

APPENDIX B

INTELLECTUAL PROPERTY

Patents.

It is understood and agreed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (Agency) that the Intellectual Property Rights policy to be employed in any particular cooperative undertaking between the parties pursuant to this Interagency Agreement (IA) which is supported in whole or in part by DOE/NV funding will be as set forth below:

(a) In any contract, subcontract, or task order under a contract where the Agency has research, development, or demonstration (R,D&D) work performed by a contractor (other than a small business firm or nonprofit organization) and the work is not severable from that funded by the Agency, the Agency will incorporate the Patent Rights clause of 48 C.F.R. Section 952.227-13, dated March 1995. Where, however, the contract, subcontract, or task order is with a small business firm or nonprofit organization, the Patent Rights clause used in the contract will be in accordance with the provisions of P.L. 96-517. Patent Rights clause at 48 C.F.R. 952.227-11, dated March 1995, will be incorporated in the latter contracts.

(b) Offerors and prospective contractors (other than small business firms or nonprofit organizations) shall be provided with notice of and the opportunity to request at any time prior to the effective date of the contract or within 30 days thereafter, an advance waiver of all or any part of the rights of the United States with respect to inventions which may be conceived or first actually reduced to practice in the course of or under a cost shared contract. The clause at 48 C.F.R. 952.227-84, dated April 1984, may be used for this purpose. The Agency Contracting Officer will promptly forward such requests to DOE's Assistant General Counsel for Patents and will notify the contractor whether such request is granted in whole or in part.

(c) When the Agency has the work performed by Agency contractors, subcontractors, or consultants via contracts or subcontracts under this IA, funded in whole or in part by DOE, the contract or subcontract will incorporate, as the Intellectual Property Rights provisions, the DOE Patent and Data Supplement to Part II--Contract Clauses DOE Set 304, dated December 22, 1995, clauses 50 through 57, for cost-reimbursement service contracts and DOE Set 301S, dated December 22, 1995, clauses 46 through 54, for fixed price service contracts. Copies of these clause sets may be accessed via the Internet through the DOE Home Page and will be made available, upon request, from the DOE/NV Contracting Officer.

(d) Where an Agency contractor, subcontractor, or consultant will not accept the Intellectual Property Rights provisions provided by DOE, the Agency will not proceed with the

contract or subcontract without written approval of the DOE Patent Counsel.

(e) When the Agency has the work performed by Agency personnel, any inventions or discoveries made or conceived in the course of or in connection with such work will be reported and processed in accordance with the standard Agency procedure. However, the Agency will also report all such inventions to the DOE/NV and obtain DOE/NV's concurrence prior to making any determination in which the Government would retain less than the entire right, title, and interest to any such invention made by an Agency employee.

(f) DOE will have unlimited rights, as that term is defined in FAR 52.227-14, to any technical data generated during the performance of work under this IA. However, it is recognized that during the course of the work, the Agency or its employees, consultants, or contractors may from time to time desire to publish, within the limits of security requirements, information regarding scientific or technical developments made or conceived in the course of or under this IA. In order that public disclosures of such information will not adversely affect the Intellectual Property interests of DOE or the Agency, patent clearances and requests to establish copyright will be secured from DOE prior to any such release or publication. Otherwise, all generated technical reports and/or other engineering materials prepared under this IA will be freely exchanged and made available to the DOE/NV Contracting Officer for release to the public unless classified or restricted.

PART II
Contract Clauses

DOE List 304 – Cost Reimbursement Service Contracts

1.	FAR	52.252-2	Clauses Incorporated by Reference (JUN 1988) This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available.
2.	FAR (OCT 1995) DEAR (APR 1994)	52.201-1 952.202-1	Definitions
3.	FAR	52.203-3	Gratuities (APR 1984)
4.	FAR	52.203-5	Covenant Against Contingent Fees (APR 1984)
5.	FAR	52.203-6	Restrictions on Subcontractor Sales to the Government (OCT 1995)
6.	FAR	52.203-7	Anti-Kickback Procedures (JUL 1995)
7.	FAR	52.203-9	Requirement for Certificate of Procurement Integrity-Modification (SEP 1995)
8.	FAR	52.203-10	Price or Fee Adjustment for Illegal or Improper Activity (SEP 1990)
9.	FAR	52.203-12	Limitation on Payments to Influence Certain Federal Transactions (JAN 1990) *Applicable only if the contract estimated cost, including fee, exceeds $100,000.*
10.	FAR	52.204-4	Printing/Copying Double-Sided on Recycled Paper (MAY 1995)
11.	DEAR	952.208-70	Printing (APR 1984)
12.	FAR	52.209-6	Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (JUL 1995)
13.	DEAR	952.212-72	Uniform Reporting System (MAY 1987)
14.	FAR	52.215-2	Audit and Records-Negotiation (OCT 1995), Alternate II (OCT 1995) *Alternate II applies if the contract is with an educational institution.*
15.	FAR	52.215-22	Price Reduction for Defective Cost or Pricing Data (OCT 1995)
16.	FAR	52.215-23	Price Reduction for Defective Cost or Pricing Data-Modifications (OCT 1995)
17.	FAR	52.215-24	Subcontractor Cost or Pricing Data (OCT 1995)
18.	FAR	52.215-25	Subcontractor Cost or Pricing Data-Modifications (OCT 1995)
19.	FAR	52.215-26	Integrity of Unit Prices (OCT 1995), Alternate I (APR 1991). *Alternate I applies if the contract is not the result of full and open competition.*

20.	FAR	52.215-27	Termination of Defined Benefit Pension Plans (MAR 1996)
21.	FAR	52.215-30	Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
22.	FAR	52.215-31	Waiver of Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
23.	FAR	52.215-33	Order of Precedence (JAN 1986)
24.	FAR	52.215-40	Notification of Ownership Changes (FEB 1995) *This clause applies if certified cost or pricing data have been submitted or if any preaward or postaward cost determination is subject to FAR subpart 31.2.*
25.	FAR	52.215-42	Requirements for Cost or Pricing Data or Information Other Than Cost or Pricing Data-Modifications (OCT 1995), Alternate IV (OCT 1995)
26.	DEAR	952.216-7	Allowable Cost and Payment (DEC 1991), Alternates I AND II
27.	FAR	52.216-8	Fixed Fee (APR 1984) *This clause applies to this contract only if the contract makes provision for the payment of a fixed fee.*
28.	FAR	52.216-11	Cost Contract-No Fee (APR 1984) *This clause applies to this contract only if the contract makes no provision for the payment of a fee.*
29.	DEAR	952.217-70	Acquisition of Real Property (APR 1984)
30.	FAR	52.219-8	Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns (OCT 1995)
31.	FAR	52.219-9	Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (OCT 1995)
32.	FAR	52.219-16	Liquidated Damages-Subcontracting Plan (OCT 1995)
33.	FAR	52.222-1	Notice to the Government of Labor Disputes (APR 1984)
34.	FAR	52.222-2	Payment for Overtime Premiums (JUL 1990)
35.	FAR	52.222-3	Convict Labor (APR 1984)
36.	FAR	52.222-4	Contract Work Hours and Safety Standards Act-Overtime Compensation (JUL 1995) *Applicable to contracts which involve the employment of laborers or mechanics.*
37.	FAR	52.222-26	Equal Opportunity (APR 1984)
38.	FAR	52.222-28	Equal Opportunity Preaward Clearance of Subcontracts (APR 1984) *This clause applies to this contract only if the estimated cost, together with any fee, is $1,000,000 or more.*
39	FAR	52.222-35	Affirmative Action for Special Disabled and Vietnam Era Veterans (APR 1984)
40.	FAR	52.222-36	Affirmative Action for Handicapped Workers (APR 1984)

41. FAR 52.222-37 Employment Reports on Special Disabled Veterans and Veterans of the Vietnam Era (JAN 1988)

42. FAR 52.222-41 Service Contract Act of 1965, as amended (MAY 1989)
Applicable if the principal purpose of the contract is to furnish services through the use of service employees as defined under Department of Labor regulations at Title 29, Code of Federal Regulations, Part 4.

43. FAR 52.222-42 Statement of Equivalent Rates for Federal Hires (MAY 1989)
Applicable if the clause at FAR 52.222-41, Service Contract Act of 1965 is applicable.

44. FAR 52.223-2 Clean Air and Water (APR 1984)
This clause applies to this contract only if the price is (a) in excess of $100,000; (b) a facility to be used has been the subject of a conviction under the applicable portion of the Air Act (42 U.S.C. 7413(c)(1)) on the Water Act (33 U.S.C. 1319(c)) and is listed by EPA as a violating facility; or (c) the acquisition is not exempt under FAR 23.104.

45. FAR 52.223-6 Drug-Free Workplace (JUL 1990)

46. FAR 52.223-14 Toxic Chemical Release Reporting (OCT 1995)

47. DEAR 952.224-70 Paperwork Reduction Act (APR 1984)

48. FAR 52.225-11 Restrictions on Certain Foreign Purchases (MAY 1992)

49. FAR 52.225-19 European Union Sanction for Services (JAN 1996)

50. FAR 52.227-1 Authorization and Consent (JUL 1995)
This clause applies only if so indicated elsewhere in this contract.

51. FAR 52.227-2 Notice and Assistance Regarding Patent and Copyright Infringement (APR 1984)
This clause applies only if the amount of this contract exceeds the dollar amount set forth in 13.000 of the Federal Acquisition Regulation.

52. DEAR 952.227-9 Refund of Royalties (MAR 95)

53. DEAR 952.227-11 Patent Rights-Retention by Contractor (Short Form) (MAR 1995)
This clause applies only if the contractor is a domestic small business or domestic nonprofit organization at the time of award.

54. DEAR 952.227-13 Patent Rights-Acquisition by the Government (MAR 1995)
This clause applies unless the Contractor is a domestic small business or domestic nonprofit organization at the time of award.

55. FAR 52.227-14 Rights in Data-General with Alternates I and V (JUN 1987)
This clause applies unless FAR 52.227-17 has been specified elsewhere in the contract.

55. FAR 52.227-16 Additional Data Requirements (JUN 1987)
This clause does not apply to this contract if the contract is for the conduct of basic or applied research, as set out elsewhere in this contract, to be performed solely by a college or university, and the estimated cost is not in excess of $500,000.

56. FAR 52.227-17 Rights in Data-Special Works (JUN 1987)
This clause applies only if specified elsewhere in the contract

57. FAR 52.227-23 Rights to Proposal Data (Technical) (JUN 1987)

58.	FAR	52.228-7	Insurance-Liability to Third Persons (MAR 1996)
59.	FAR	52.232-17	Interest (JAN 1991) *This clause applies to this contract unless (1) the contractor is (a) a Federal Agency; (b) a State of local government or instrumentality; (c) a foreign government or instrumentality or (d) a nonprofit organization, and the contract makes no provisions for the payment of a profit or fee; or (2) the contract is one for paid advertisements pursuant to Subpart 5.5.*
60.	FAR	52.232-20	Limitation of Cost (APR 1984) *This clause applies to this contract if it is a fully-funded contract.*
61.	FAR	52.232-22	Limitation of Funds (APR 1984) *This clause applies to this contract if it is an incrementally-funded contract to which the final funding increment has not been allotted.*
62.	FAR	52.232-23	Assignment of Claims (JAN 1986)
63.	FAR	52.232-25	Prompt Payment (SEP 1992)
64.	FAR	52.232-28	Electronic Funds Transfer Payment Methods (APRIL 1989)
65.	FAR	52.233-1	Disputes (OCT 1995), Alternate I (DEC 1991)
66.	FAR	52.233-3	Protest after award (AUG 1989), and Alternate I (JUN 1985)
67.	DEAR	952.235-70	Key Personnel (APR 1995)
68.	FAR	52.242-1	Notice of Intent to Disallow Costs (APR 1984)
69.	FAR	52.242-3	Penalties for Unallowable Costs (OCT 1995) *This clause applies if this contract is for an amount over $500,000.*
70.	FAR	52.242-13	Bankruptcy (JUL 1995)
71.	FAR	52.242-15	Stop-Work Order-Alternate I (APR 1984)
72.	FAR	52.243-2	Changes (Cost-Reimbursement) Alternates I and V (AUG 1987) *Alternate V applies if the purpose of the contract is research and development.*
73.	FAR	52.244-2	Subcontracts (Cost-Reimbursement and Letter Contracts) (MAR 1996)
74.	FAR	52.244-5	Competition in Subcontracting (JAN 1996)
75.	FAR	52.244-6	Subcontracts for Commercial Items and Commercial Components (OCT 1995)
76.	DEAR	952.245-5	Government Property-Cost-Reimbursement, Time-and-Material, or Labor-Hour Contracts), Alternate I (JUL 1985) *Alternate I applies if the contract is for research at nonprofit institutions of higher education or other nonprofit organizations whose primary purpose is the conduct of scientific research as may be indicated in Section H of the contract.*
78.	FAR	52.246-5	Inspection of Services-Cost-Reimbursement (APR 1984) *This clause applies unless the contract is for research and development*
79.	FAR	52.246-8	Inspection of Research and Development (Cost-Reimbursement) Basic and Alternate I (APR 1984)

This clause applies if the contract is for the conduct of research and development. Alternate I applies if the contract is on a no fee basis.

80.	FAR	52.246-25	Limitation of Liability–Services (APR 1984)
81.	FAR	52.247-63	Preference for U.S.-Flag Air Carriers (APR 1984)
82.	FAR	52.247-64	Preference for Privately Owned U.S.-Flag Commercial Vessels (JUL 1995)
83.	DEAR	952.247-70	Foreign Travel (APR 1984)
84.	FAR	52.249-5	Termination of the Government (Educational and Other Non-Profit Institutions) 8APR 1984) *This clause applies if the contract is for research and development work with an educational or nonprofit institution on a no-profit or no-fee basis.*
85.	FAR	52.249-6	Termination (Cost-Reimbursement) (MAY 1986) *This clause applies to this contract unless the contractor is an educational or nonprofit institution, and the contract makes no provision for the payment or a profit or fee.*
86.	FAR	52.249-14	Excusable Delays (APR 1984)
87.	DEAR	952.251-70	Contractor Employee Travel Discounts (JUN 1995)

United States Environmental Protection Agency
Washington DC 20460

EPA

Interagency Agreement / Amendment

Part I - General Information

1. EPA / IAG Identification Number: RW89937611-01-0
2. Other Agency ID Number: DE-AI08-96NV11969
3. Type of Action: NEW PROJECT
4. Funding Location by Region: HQ
5. Program Office Abbreviation: OAR/ORIA/RSL

6. Name and Address of EPA Organization
ENVIRONMENTAL PROTECTION AGENCY
RADIATION SCIENCES LABORATORY
P.O. BOX 98517
LAS VEGAS, NV 89193-8517

7. Name and Address of Other Agency
ENERGY, DEPARTMENT OF
NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518

8. Project Title: TO PROVIDE CONTINUED SUPPORT TO ENVIRONMENTAL RESTORATION & WEAPONS PROGRAMS

9. EPA Project Officer (Name, Address, Telephone Number)
WEEDEN, PAUL J., DIRECTOR
EPA/OAR/ORIA/RSL
P.O. BOX 98517
LAS VEGAS, NV 89193-8517
(702) 798-2301

10. Other Agency Project Officer (Name, Address, Telephone Number)
MONROE, LESLIE A., EPD
DOE/NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518
(702) 295-1744

11. Project Period: 09/01/96 to 08/31/01

12. Budget Period: 09/01/96 to 08/31/01

13. Scope of Work (Attach additional sheets, as needed)

SCOPE OF WORK ATTACHED

THE EPA GRANTS SPECIALIST FOR THIS IAG IS
FELICA A. TARVER, PHONE NO. 202-260-8277

14. Statutory Authority for Both Transfer of Funds and Project Activities
ECONOMY ACT OF 1932 AS AMENDED

15. Other Agency Typ: FEDERAL AGENCY

FUNDS	PREVIOUS AMOUNT	AMOUNT THIS ACTION	AMENDED TOTAL
16. EPA Amount	0	0	
17. EPA In-Kind Amount	0	0	
18. Other Agency Amount	0	522,163	
19. Other Agency In-Kind Amount	0	0	
20. Total Project Cost	0	522,163	

21. Fiscal Information

Site Name	DCN	FY	Approp.	Budget Org.	Program Elem.	Object	Site/Project	Cost Org.	Obligatic
		96	CR	33D0X01	RLU				522,16

Part II - Approved Budget		EPA IAG Identification Number RW89937611-01-0
22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	350,000	350,000
(b) Fringe Benefits	0	0
(c) Travel	20,000	20,000
(d) Equipment	63,883	63,883
(e) Supplies	78,280	78,280
(f) Procurement / Assistance	10,000	10,000
(g) Construction	0	0
(h) Other	0	0
(i) Total Direct Charges	522,163	522,163
(j) Indirect Costs: Rate 0.00 % Base $ _____.	0	0
(k) Total: (EPA Share: 0.00 %) (Other Agency Share 100.00%)	522,163	522,163

23. Is Equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? ☐ Yes ☒ No
(Identify all equipment costing $1000 or more.)

24. Are any of these funds being used on extramural agreements? (See Item 22f.) ☒ Yes ☐ No

Type of extramural agreement ☒ Grant ☐ Cooperative Agreement ☒ Procurement (includes Small Purchase Order)

Contractor / Recipient Name (If known)	Total Extramural Amount under this Project	Percent Funded by EPA (If known)
VARIOUS	522,168	0.00

Part III - Funding Methods and Billing Instructions

25.

☐ Funds-Out Agreement (Note: EPA Agency Location Code (ALC) - 68010727)

☐ Disbursement Agreement

☐ Repayment Request for repayment of actual costs must be itemized on SF-1080 and submitted to the Financial Management Office, Cincinnati, OH 45268:
☐ Monthly ☐ Quarterly ☐ Upon Completion of Work

☐ Advance Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

☐ Allocation Transfer-Out Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Hdqtrs. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. ☒ Funds-In Agreement

☒ Reimbursement Agreement ☒ Repayment ☐ Advance

☐ Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Resp. Center No.
DE-AI08-96NV11969	33D
Other Agency's Billing Address *(include ALC or Station Symbol Number)*	**Other Agency's Billing Instruction and Frequency**
Department of Energy Nevada Operations Office ATTN: Financial Management Division, P.O. Box 98518	ON-LINE PAYMENT AND COLLECTION (OPAC SYSTEM IS USED

Part IV - Acceptance Conditions

EPA IAG Identification Number: RW89937611-01-0

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-in actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address US Environmental Protection Agency Grants Operations Branch B Grants Administration Division 401 M Street, SW (3903F) Washington, DC 20460	30. Organization/Address U.S. ENVIRONMENTAL PROTECTION AGENCY RADIATION SCIENCES LABORATORY P.O. BOX 98517 LAS VEGAS, NV 89193-8517

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	E. RAMONA TROVATO, DIRECTOR, ORIA	

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	W. SCOTT McMORAN, CHIEF GOB B/GAD	

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	BRADLEY M. BOURN, CONTRACTING OFCR.	

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

SEP 12 1996

U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division
ATTN: Wayne Marchant
Director
P.O. Box 93478
Las Vegas, Nevada 89193-3478

SUBJECT: RESPONSE TO EXEMPTION REQUEST DATED JULY 3, 1996

Your letter of July 3, 1996, which requested a continuation of the exemption to 10 CFR 20.1501 for your in-house DOELAP dosimetry services, was forwarded to NRC Headquarters for review on July 10, 1996. We received their response on September 9, 1996. On September 11, 1996, this matter was discussed with Paul Weeden, Anita Mullen, and Chris Fontana of your staff. The purpose of this letter is to forward Headquarter's comments and to document the telephone conversation referenced above.

NRC Headquarter's staff indicated that, at the time the original exemption was granted, the NVLAP and DOELAP dosimetry testing protocols were comparable. However, in the interim, the NVLAP program, ANSI N13.11,"Personnel Dosimetry Performance-Criteria for Testing," has been substantially modified with the issuance of the 1993 revision. This standard contains differences from those currently in use by the DOELAP program, DOE/EH-0027. The standards differ in some of the spectra used in the low-energy photon testing categories, in the beta radiations used in the beta and mixed photon-beta categories, in the neutron sources used in the neutron category, and in the absence of the angular response category from the DOELAP standard. In addition, there are differences in the testing acceptance criteria. Requirements for determination of the lower limits of detection for the dosimeters used in testing are also different.

The response from Headquarters also noted that DOE's 10 CFR 835.1(b)(1) exempts from Part 835 "activities that are regulated through a license by the Nuclear Regulatory Commission." It was noted that the use of NVLAP-accredited dosimetry is one such activity.

Their reply further stated that, unless there were strong reasons for continuing the exemption, it should not be renewed. The DOELAP accreditation would be recognized until it expires, and then NVLAP accreditation should have been obtained.

In the telephone conversation on September 11, 1996, Anita Mullen stated that there is an Interagency Agreement with DOE which tasks the EPA Las Vegas with supplying between two and three hundred dosimeters for DOE. This agreement is also the basis for the funding for their dosimetry program. Some dosimeters are for personnel use, while others are for environmental monitoring. The agreement presupposes the use of the existing DOELAP system. There are only an additional 20 to 25 dosimeters which are processed quarterly for the laboratories operating under the NRC license. Anita Mullen also stated that to obtain NVLAP accreditation would be costly. She stated that she could obtain an estimate of the cost.

The licensee representatives indicated that the DOELAP accreditation was more appropriate for their use. They did not believe that the technical differences between the two programs should be issues for their facility. Anita Mullen and Chris Fontana were going to explore this matter further. For example, they indicated that the angular response testing was already being performed, although not required by the DOELAP standard.

It was noted that the current DOELAP accreditation expires in January of 1997.

To allow us to continue consideration of your exemption request, you should submit a description of the reasons it should be continued. This should include a copy of the Interagency Agreement with DOE, an estimate of the financial burden involved in obtaining NVLAP accreditation, and a discussion of why the technical differences between the NVLAP and DOELAP programs are not an issue for your licensed program. Your reply will be forwarded to NRC Headquarters for review.

To continue prompt review of your exemption request, we ask that you submit your response to this letter in duplicate, and refer to Mail Control No. 571951.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Docket: 030-06981
License: 27-05861-02
Control: 571951

bcc:

Sami Sherbini, HQRS
Docket File
WCFO Inspection File
LFDCB, T-9 E10

DOCUMENT NAME: G:\beth\DOELAP

To receive copy of document, indicate in box: "C" = Copy without enclosures "E" = Copy with enclosures "N" = No copy

MB	N								
BPrange BAP									
09/11/96		09/ /96		09/ /96		09/ /96		09/ /96	

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 4, 1996

MEMORANDUM TO: Frank A. Wenslawski, Chief
Materials Branch, WCFO

FROM: Donald A. Cool, Director
Division of Industrial and
Medical Nuclear Safety, NMSS

SUBJECT: REQUEST BY EPA- LAS VEGAS FOR EXEMPTION FROM 10 CFR 20.1501(c) - NVLAP ACCREDITATION

I am responding to your TAR dated July 10, 1996 (attached). In the request, you noted that the license for the EPA - Las Vegas operation is in timely renewal, and that you recommend that License Condition 25 in the current license be included in the renewed license. Condition 25 gives the licensee an exemption from 10 CFR 20.1501(c), which requires that the thermoluminescent dosimeters (TLD) used by the licensee on their site, for monitoring occupational exposures, be processed by a processor accredited under the National Voluntary Laboratory Accreditation Program (NVLAP). Instead, the processor would be accredited under the corresponding Department of Energy (DOE) program, DOE Laboratory Accreditation Program (DOELAP). This license condition was granted on the basis of guidance from NRC Headquarters dated March 24, 1992.

The rationale for the exemption was that EPA-Las Vegas was, and continues to be, engaged in activities under a DOE contract, and that accreditation under DOELAP would thereby facilitate their operations within the DOE facilities. At the time the exemption was granted, the NVLAP and DOELAP dosimetry testing protocols were comparable, and use of DOELAP in place of NVLAP did not represent a significant deviation from accepted NRC practices. However, in the interim, the testing standard used by the NVLAP program, ANSI N13.11, "Personnel Dosimetry Performance - Criteria for Testing," has been substantially modified with the issuance of the 1993 revision. This standard, currently in use in the NVLAP program, contains significant differences from the previous standard, and therefore also from the standard currently in use by the DOELAP program, DOE/EH-0027. The correspondence between NVLAP and DOELAP is therefore less than it was when the license condition was

Contact: Sami Sherbini, IMOB
(301) 415-7902

first granted. The standards differ in some of the spectra used in the low-energy photon testing categories, in the beta radiations used in the beta and mixed photon-beta categories, in the neutron sources used in the neutron category, as well as in the absence of the angular response category from the DOELAP standard. In addition, there are differences in the testing acceptance criteria between the DOELAP and NVLAP standards. Requirements for determination of the lower limits of detection for the dosimeters used in testing are also different in the two standards.

Based on conversations with the licensee, we understand that the desire to continue the inclusion of Condition 25 in the license is based mainly on historical reasons, namely that the TLD system now in use in accredited under DOELAP, and it is convenient to continue use of such an established system. Removal of this condition from the license would require the licensee to obtain accreditation under NVLAP, a process that could prove costly and time-consuming. However, in view of the differences between the two standards noted above, this is not sufficient reason to grant the exemption. In addition, even though the licensee conducts work at DOE facilities, they may use NVLAP-accredited dosimetry, as provided by DOE's regulations. DOE's 10 CFR 835.1(b)(1) exempts from Part 835 "activities that are regulated through a license by the Nuclear Regulatory Commission." Use of NVLAP-accredited dosimetry is one such activity.

Therefore, unless the licensee provides a sufficiently strong reason for continuing the exemption, we believe that License Condition 25 should no longer be included in the renewed license. Reasons for granting the exemption include the presence of radiation sources in the work environment that are significantly different from those included in the NVLAP testing standard but included in DOELAP, a requirement to be DOELAP accredited, or inordinately high financial burdens involved in obtaining NVLAP accreditation. The licensee should be permitted to continue operation under their current DOELAP accreditation until it expires, and in the meantime prepare for accreditation under NVLAP.

Please call the technical contact if you need further information or clarifications.

Attachment: As stated

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

July 10, 1996

MEMORANDUM TO: Donald A. Cool, Director
Division of Industrial and Medical Nuclear Safety, NMSS

FROM: Frank A. Wenslawski, Chief
Materials Branch

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS
CONTROL 571951

This Technical Assistance Request (TAR) is sent to you to determine whether an exemption from 10 CFR 20.202(c)--now 10 CFR 20.1501(c)--can be continued when the license is renewed (the license is in timely renewal status). License Condition 25. currently allows the licensee to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP). This matter was previously sent to Headquarters in a TAR dated January 23, 1992. In a response dated March 24, 1992, it was stated that Headquarters had reviewed the DOELAP program and had determined that it satisfied the criteria outlined in NVLAP. For this reason, it was recommended that EPA's request be approved.

We recommend that their request for renewal of this exemption be granted. If their request cannot be granted, please specify the reasons.

If further information is required, contact Beth Prange at (510) 975-0250.

Enclosures:

TAR Form dated July 9, 1996
Letter dated July 3, 1996
Handbook for the DOELAP for Personnel Dosimetry Systems
DOE Standard for the Performance Testing of Personnel Dosimetry Systems
Amendment No. 22 to License No. 27-05861-02

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: July 9, 1996

Mail or E-Mail to: Donald A. Cool, Mail Stop: TWFN 8F5 If E-mail, cc: DAC
Division of Industrial and Medical Nuclear Safety, NMSS

From: Frank A. Wenslawski (FAW) Region IV, WCFO
Chief, Materials Branch

Licensee: EPA, Las Vegas License No.: 27-05861-02

Control No. 571951

Letter dated: July 3, 1996

☐ Problem/Issue: The licensee wishes to renew an exemption from 10 CFR 20.202(c)---now 10 CFR 20.1501(c)---to allow them to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

☐ Action Required: Review their request and determine whether the exemption can be continued. If not, specify the reasons.

Recommended Action (with revisions): X Approve

Headquarter Reviewer: (For HQ use)
Regional Reviewer: Beth Prange (BAP1)
Reviewer Code: W1
Reviewer Phone No.: (510)975-0250 FAX No.: (510)975-0381
Request Needed by: 09/09/96

Form TAR-10
9/93

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

OFFICE OF
RESEARCH AND DEVELOPMENT

July 3, 1996

U.S. Nuclear Regulatory Commission-Region IV
Walnut Creek Field Office
Attention: Materials (Licensing) Branch, Beth A. Prange
1450 Maria Lane
Walnut Creek, CA 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981
Control No. 571951

Subject: Exemption to 10 CFR 20.202(c) (now 10 CFR 20.1501)

Dear Ms. Prange:

As you suggested in your letter dated May 28, 1996, and during our conference call yesterday, I am enclosing two copies of DOE/EH-0026 and DOE/EH-0027. Both are current and dated December 1986. In connection with our pending license renewal application, I request continuance of our exemption to 10 CFR 20.1501 for our in-house dosimetry services for our radiation workers.

If you need additional information, please call me at 702-798-2525, or our Radiation Safety Officer, Loyd Carroll, at 702-798-2313.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

2 Enclosures (2 ea)

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (40% Postconsumer)

57195

DOE/EH-0026
Distribution Category: UC-41

HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health
Washington, D.C. 20545

FOREWORD

The program contained in this Handbook provides a significant advance in the field of radiation protection through a structured means for assuring the quality of personnel dosimetry performance. This program culminates an effort initiated by DOE's predecessor in early 1963. Since personnel dosimetry performance is directly related to the assurance of worker safety, it has been of key interest to the Department of Energy (DOE) (and its predecessor agencies). Studies conducted over the past three decades have clearly demonstrated a need for personnel dosimetry performance criteria, related testing programs, and improvements in dosimetry technology. In responding to these needs, the DOE Office of Nuclear Safety (EH) has developed and initiated a DOE Laboratory Accreditation Program (DOELAP) which is intended to improve the quality of personnel dosimetry through (a) performance testing, (b) dosimetry and calibration intercomparisons, and (c) applied research.

In the interest of improving dosimetry technology, the DOE Laboratory Accreditation Program (DOELAP) is also designed to encourage cooperation and technical interchange between DOE laboratories. Dosimetry intercomparison programs have been scheduled which include the use of transport standard instruments, transport standard radioactive sources and special dosimeters. The dosimeters used in the intercomparison program are designed to obtain optimum data on the comparison of dosimetry calibration methodologies and capabilities. This data is used in part to develop enhanced calibration protocols. In the interest of overall calibration update, assistance and guidance for the calibration of personnel dosimeters is available through the DOELAP support laboratories.

To further the efforts in dosimetry upgrade we are also encouraging a closer cooperation and working relationship between the researcher and those involved in performance testing. Feedback to the DOE dosimeter processors on dosimeter performance and applied research efforts will be provided by DOELAP.

The relationship between the DOELAP and the NVLAP (National Voluntary Laboratory Accreditation Program) which services NRC licensees has also been established. The DOE recommended to the Interagency Policy Committee on Personnel Dosimetry, a program, which integrates the DOELAP and NVLAP under the National Dosimetry Accreditation Upgrade Program through an efficient flow of information between the programs. The DOELAP and NVLAP utilize similar methodology. However, the DOELAP is more comprehensive through necessity because of the complexities of the DOE programs to be accredited and the need for more restrictive performance testing.

The DOELAP is basically contained in four documents:

1. "DOE Order 5480 Series,"
2. "Department of Energy Standard for the Performance Testing of Personnel Dosimetry Systems" (provides testing criteria to accredit personnel dosimeters) - DOE/EH-0027,
3. "Handbook for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (provides operating procedures for program), and
4. "Quality Assurance Manual for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (applies to the performance testing laboratory only) - DOE/ID-12105.

E. J. Vallario, Group Leader
Health Physics Programs
Office of Nuclear Safety
U.S. Department of Energy

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HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

The Department of Energy (DOE) and its predecessor agencies have been concerned about personnel dosimetry performance since the late 1950s. Studies conducted over the past three decades have clearly demonstrated DOE needs both performance criteria for personnel dosimetry and a testing program to determine the criteria have been met.[1-13]

In 1973, the Conference of Radiation Control Program Directors recommended establishing a program for continually testing personnel dosimetry performance throughout the United States. The Conference appointed a task force with state and federal participants to implement this recommendation. The task force concluded that existing standards were inadequate for the purpose. It asked the Health Physics Society Standards Committee (HPSSC) to develop a new Standard to establish criteria for testing personnel dosimetry performance. In 1975, HPSSC charged a working group with writing such a Standard for the American National Standards Institute as ANSI Standard N13.11.[14]

In 1976, the Conference of Radiation Control Program Directors, the Nuclear Regulatory Commission (NRC), predecessor agencies of DOE, and the National Center for Devices and Radiological Health (NCDRH) jointly sponsored a public meeting. This meeting was held to discuss the problems associated with personnel dosimetry. At that meeting copies of the draft standard *Criteria for Testing Personnel Dosimetry Performance*, which HPSSC had developed, were distributed. Many of those attending the meeting strongly recommended a pilot study be undertaken to evaluate the draft standard. As a result of that recommendation, the University of Michigan conducted three rounds of personnel dosimetry proficiency testing from 1977 to 1982. Upon completion of the University of Michigan studies, the standard was adopted as a Health Physics Society Standard. The Board of Standards Review of ANSI accepted it as a final American National Standard.[14] The National Voluntary Laboratory Accreditation Program (NVLAP) is using it as a basis for an accreditation program for personnel dosimeters.[15]

Independent of the University of Michigan testing program, DOE conducted a program to evaluate ANSI N13.11 for use in its DOE/DOE contractor personnel dosimetry programs. The studies DOE conducted have demonstrated ANSI N13.11 is not adequate for testing the personnel dosimeters used at DOE/DOE contractor facilities.[12] Accordingly, DOE developed a comprehensive Standard for performance testing its personnel dosimetry systems.[16] The Standard is a modification of ANSI N13.11[14] and is based on recommendations made while evaluating the ANSI Standard. Moreover, DOE wanted a testing program that would encourage further research and promote communication among the DOE/DOE contractor organizations. This kind of program would bring about new developments and procedures to be used to improve dosimetry performance. Therefore, DOE decided to establish a dosimetry testing program consistent with its needs. The program is called the DOE Laboratory Accreditation Program (DOELAP). DOE intends to eventually coordinate its testing program with that of NVLAP. Therefore, DOELAP follows NVLAP methods and procedures as much as possible.

Accreditation is the assessment of whether or not a personnel dosimetry system meets specific criteria. The assessment includes dosimeter performance and the associated quality assurance and calibration programs. The accreditation process includes the development of recommendations for any improvements needed to ensure continuing quality. DOELAP's objective is to accredit the personnel dosimetry systems of DOE/DOE contractors, regardless of whether the dosimeter processing is conducted at commercial or in-house facilities. The term "DOE contractor" will refer to the DOE/DOE contractor facility eligible for accreditation. The term "processor" is limited to the facility handling and evaluating the personnel dosimeters.

This handbook describes the procedures for obtaining accreditation. In general, to obtain accreditation, contractors must:

1. Meet the test criteria in the DOE Standard
2. Pass an onsite assessment of the documentation, quality assurance, and technical adequacy associated with personnel dosimetry systems.

A performance testing laboratory determines the ability to meet the test criteria. Members of a team of experts in personnel dosimetry conduct onsite assessments. The Standard is consistent with the current capabilities of dosimetry systems. However, it will be upgraded as improved dosimetry capabilities become available. This particularly applies to beta-particle and neutron dosimetry.

2. SCOPE OF ACCREDITATION PROGRAM

The DOELAP for personnel dosimetry systems applies to the technical aspects of personnel dosimetry systems at DOE/DOE contractor facilities and to the documentation of those aspects. During the accreditation:

1. A performance testing laboratory evaluates the technical performance of dosimetry systems
2. An onsite assessment studies the quality assurance, documentation, and technical adequacy of such systems.

Dosimeter types or models used to determine whole-body and skin dose for personnel are included in the scope of the Accreditation Program. Accreditation currently does not apply to extremity dosimeters, pocket ionization chambers, thermal neutron dosimetry, and high-energy neutron dosimetry. The program scope does not forbid a laboratory to provide additional dosimetry services (i.e., personnel, extremity, environmental, or area monitoring). Nor does it preclude a laboratory from operating research programs to improve the dosimetry services. Calibration services are accessible, for a fee, to laboratories requiring characterization of dosimetry systems in routine use or under development.

The DOELAP allows abbreviated testing for dosimeter types known or suspected to be noncompliant in certain categories. The dosimeter type will be considered adequate or accreditable only if it is used in those environments covered by the categories for which it was successfully tested.

The DOELAP test standard scope is limited. Approximate energy intervals covered are: 15 keV to 2 MeV for photons; above 0.3 MeV for beta particles; and 1 keV to 2 MeV for neutrons. Additional test categories covering other energy ranges are being developed as the need arises and time permits. DOELAP does not currently cover occupational environments containing significant contributions outside these ranges. Processors are not required to test dosimeters used for these environments.

Every two years, each DOE contractor must maintain its accreditation by demonstrating compliance with DOELAP criteria.

3. ADMINISTRATION OF THE PROGRAM

The DOELAP is managed by the DOE Office of Nuclear Safety. The DOE Headquarters (HQ) DOELAP Administrator provides for the overall program management. An Oversight Board technically reviews DOELAP protocol and makes recommendations concerning accreditation. The Oversight Board consists of five DOE/DOE contractor personnel. Each serves a 2-year term. An Appeals Board considers contractor appeals concerning accreditation denial. It consists of six DOE/DOE contractor personnel. The performance evaluation program at the DOE Radiological and Environmental Sciences Laboratory (RESL) at the Idaho National Engineering Laboratory (INEL) coordinates the accreditation process. The Performance Evaluation Program Administrator at RESL is responsible for conducting the performance testing and site assessment programs and for maintaining all documentation associated with DOELAP.

The HQ DOELAP Administrator will periodically request nominations for a pool of technical experts to serve in this accreditation program. The experts are selected by evaluating their professional and academic achievements and their experience in dosimetry. The onsite assessors, members of the Oversight Board, and of the Appeals Board are selected from this pool. Each board will select its own chairman.

4. ACCREDITATION PROCESS

The Performance Evaluation Program Administrator coordinates the accreditation process for personnel dosimetry systems. To obtain accreditation, a DOE contractor must first submit an application through the field office. The contractor must then satisfy both the performance testing and the onsite assessment requirements. The Performance Evaluation Program Administrator prepares an administrative report documenting the test results and recommendations for accreditation. The Oversight Board evaluates the report and the recommendations and, if approved, sends them to the HQ DOELAP Administrator. The HQ DOELAP Administrator makes the final decisions on accreditation and issues the Certificates of Accreditation. A Certificate of Accreditation specifies the model(s) or type(s) of dosimeters accredited for specific radiation categories.

If a dosimetry system, or part of a dosimetry system, is found noncompliant with DOELAP criteria, the contractor and field office prepare a remedial action plan to implement immediately. The plan is sent through the DOE field office to the HQ DOELAP Administrator with a copy to the Performance Evaluation Program Administrator. The contractor and field office may appeal to the Appeals Board at any point in the accreditation process. In the meantime, the dosimetry system may be partially accredited. If the system has demonstrated satisfactory performance in a subset of the DOELAP irradiation categories and if the remedial action plan is initiated, the accreditation process may continue in those categories. When more than one dosimeter design is used to meet the special needs at a laboratory, it is possible for a portion of a dosimetry system to receive final accreditation while the remaining part requires a remedial action plan.

If a DOE contractor uses the services of a commercial processor, both the contractor and processor facilities will be visited. If more than one DOE contractor is using the same commercial processor, only one site visit to the processor may be required. More than one DOE contractor may use performance test data for a commercial processor if each contractor facility uses the identical dosimeter design and if the appropriate test categories are included. Site-specific calibration factors and response algorithms are required if used for routine evaluations. The Performance Evaluation Program Administrator must approve combined evaluations, and the Oversight Board must review them.

The following sections describe the phases of the accreditation process in more detail.

4.1 Application

The contractor initiates the accreditation process by submitting an application form (Appendix A) through the appropriate field office. To expedite the process, a designated representative of the applying laboratory management (e.g., the laboratory's head health physicist) should complete the application as thoroughly as possible and sign it. The designated representative should be familiar with all DOELAP requirements. The representative reviews all documents and acts as liaison between DOE/DOE contractor management and the Performance Evaluation Program Administrator. Other staff members may be designated to perform specific activities (e.g., handling proficiency testing or receiving an assessor). Yet, only one designated individual should be responsible for requesting a change in the scope or nature of the accreditation.

The application requires each applicant to describe the particular processing system employed. The description should include the specific apparatus and protocols used and whether processing is done manually or automatically. It should also identify the equipment and procedures to be used for the appropriate testing categories. The information submitted should describe the system used as thoroughly as possible without divulging proprietary information.

The application is used to:

- Enroll the DOE/DOE contractor facility in the program
- Determine the dosimeter types or models and test categories desired for accreditation
- Gather information about the DOE/DOE contractor's facility and organizational structure for evaluation purposes
- Select assessors with the proper technical background for the onsite visit
- Gather information necessary to prepare for an onsite visit.

The contractor sends the application to the appropriate field office. There, it is reviewed and, if approved, sent to the Performance Evaluation Program Administrator.

4.2 Performance Test

Performance testing is the first requirement of the DOELAP accreditation process. The procedures contained in the DOE Standard are briefly highlighted in this section.

A dosimeter type may be accredited in one or more of the radiation categories shown in Table 1. This table contains the source specification, energies, and dose range for each category. The contractor must specify the exposure categories and the types or models of the dosimeters submitted for accreditation.

The test period is three to six months. The contractor must submit three shipments of dosimeters during this test period to the performance testing laboratory for irradiation. The contractor shall normally submit five dosimeters in each test category with each shipment. The contractor will be required to include a specified number of additional dosimeters of each design in each shipment to be used as controls and when necessary as replacements. The Standard specifies certain cases where 10 dosimeters per category per shipment may be submitted for irradiation. These cases must be coordinated with the DOELAP Performance Evaluation Program Administrator.

The dosimeters are then irradiated and returned to the contractor. The contractor must read each one and determine a dose or dose equivalent. The testing laboratory will identify all dosimeters irradiated in Categories I and II and those irradiated for the neutron tests (Categories VI & VII). Dosimeters irradiated in the mixture categories Categories III, IV, and V and VII (not including neutron irradiations) are not identified by category. In these cases, the processor must determine the dose for each dosimeter without knowing the irradiation category. Pretest calibration exposures for neutron categories are recommended and will be provided upon request. The contractor will identify the neutron field(s) to be used for the performance testing. Besides identifying the dosimeters irradiated by the neutron sources to the contractor the testing laboratory will provide the ratio of responses of a BF_3 detector in a 9-in.-dia sphere and in a 3-in.-dia sphere covered with 10-mil-thick cadmium. The ratio gives the contractor a relative calibration for albedo dosimeters. This information may be useful to relate the test fields to the neutron fields in the occupational environment.

The radiation sources and geometries are described fully in the Standard. A brief description of them follows:

1. A sealed ^{137}Cs gamma-ray source
2. X-ray machine(s) producing continuous spectra using the techniques of the National Bureau of Standards,[18] and capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV).
3. A sealed $^{90}Sr/^{90}Y$ beta particle source with a 100-mg/cm^2 filter (nominal) to remove the ^{90}Sr component - The residual maximum energy, as defined in the International Standard ISO 6980,[19] shall equal or exceed 1.80 MeV. The in-phantom dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 1.01 ± 0.03. The in-phantom dose rate at 1000 mg/cm^2 shall be less than 1% of the dose rate at 7 mg/cm^2. The measurement specifications take precedence over the irradiation geometry specifications.
4. A sealed ^{204}Tl source filtered by 50 mg/cm^2 (nominal) - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV. The in-phantom dose rate at 20 mg/cm^2 divided by the in-phantom dose rate at . mg/cm^2 shall be 0.80 ± 0.05. The measurement specifications take precedence over the irradiation geometry specifications.
5. A natural or depleted uranium slab - The source protective covering shall be in the range between 3 mg/cm^2 and 7 mg/cm^2 inclusive. The dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 0.58 ± 0.04. The measurement specifications take precedence over the geometry specifications. The dimensions of the source must exceed the dimensions of irradiated dosimeters.
6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[17]

The Standard of performance for DOELAP is based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically

Table 1. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 1. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]		0.05-5 rem	Shallow,
III & V	One energy	0.2-5 rem	Deep
IV & V[a]	from each	0.2-5 rem	
III & VI[h]	category	0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 14.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 17).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[13] A test criterion:

$$| B | + S \leq 0.30^{a} \qquad (1)$$

can be interpreted as providing approximately 70% confidence a dosimeter response would be within 30% of a conventionally true value. For workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence the annual reported dose equivalent would be within 30% of a conventionally true value.

The criterion in Equation (1) is consistent with the recommendations of the National Council on Radiation Protection and Measurement (NCRP), the International Commission on Radiation Units and Measurements (ICRU), and the International Commission on Radiological Protection (ICRP). Reference 16 points out the following caveats:

- The NCRP and ICRU recommend 30% for the accuracy with 95% confidence. To meet these requirements, at least four dosimeters receiving approximately equal doses must be used to determine the annual dose.
- The recommendation by the ICRP of accuracy within a factor of 1.5 at the 95% confidence level is approximately met for each dosimeter (and thus for each worker). However, the uncertainty due to angular response included in the ICRP accuracy recommendations is neglected in the test criteria. The criterion in Equation (1), using quarterly exchange rates to achieve 95% confidence, is the approximate equivalent of reserving up to 20% additional bias for angular response variations.
- The NCRP recommends 20% accuracy at high doses. The ICRU and ICRP favor a special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions are neglected in the test criterion. Examples of such unknowns are the position of dosimeter relative to source distribution or its location on the body of the wearer.

The criterion in Equation (1) was modified to reduce the probability of a failure due to the imprecise delivery of dose equivalent to the test dosimeters and to permit more time for fine adjustments in the mixture categories. The DOELAP Test criterion is:

$$| B | + S - | E | \leq L \qquad (2)$$

where

$L = 0.30$ for Categories I through VI

$L = 0.40$ for Category VII

and E is the estimated fractional uncertainty in the delivered dose or dose equivalent rate. The performance testing laboratory determines the value of E. It will typically be in the range between 1% and 4%.

The test for the low-energy beta source listed in Table 1 does not require using Equation (2) because of the technological and practical limitations of current dosimeter designs. Instead, this less stringent test is used for ^{204}Tl:

$$| B | - | E | \leq 0.40 . \qquad (3)$$

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a. Bias (B) - the average of the performance quotients, P_i, for n dosimeters, for a specific irradiation category and depth.

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1a)$$

where

$$P_i = \frac{(\text{Reported})_i - (\text{Delivered})_i}{(\text{Delivered})_i} .$$

Standard Deviation (S) - The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth.

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)^2}{n - 1} \right]^{1/2} \qquad (1b)$$

This criterion was chosen based on the low-energy beta performance of current DOE dosimetry systems, as discussed in the Standard.[16] The ^{204}Tl source is not used in any mixture categories unless requested by a participant. The performance criteria for Category VII and for the ^{204}Tl tests will be upgraded to that of the other categories and sources two years after the effective date of the DOE Order.[20]

The dose interpretation algorithms used for reporting occupational doses should be used for the performance tests, if practical. If changing an algorithm to meet the DOE Standard specifications increases the error of reported occupational doses, that algorithm should not be changed. Using different calibration factors for the tests and for various occupational environments is justified if it results in an improved dose estimation. The contractor must document the relationship between the algorithms used for the test and the reported worker doses. The contractor must also justify the use of environment-dependent factors.

The categories for low-energy photon and beta particles offer a choice of sources. The "A" categories are for general sources, the "B" or "C" categories for specific occupational environments or applications. For example, Category IIIA is for general low-energy photon environments. Category IIIB applies specifically to plutonium environments. Testing in both subgroups of Category III is appropriate for a dosimeter used in both plutonium and nonplutonium environments with significant x-ray fields. Different dose interpretation algorithms may be used for Categories IIIA and IIIB if they are the same ones used to estimate the occupational doses.

The beta particle categories are for general beta environments ($^{90}Sr/^{90}Y$ and ^{204}Tl point sources—Category VA), environments containing uranium sources (slab uranium—Category VB), and environments having predominantly high-energy or low-energy betas (a $^{90}Sr/^{90}Y$ or a ^{204}Tl point source—Category VC). The sources in Category VA have energy spectra suitable for an energy response test for beta fields. According to Reference 19, an energy response test may include ^{147}Pm, ^{204}Tl, and $^{90}Sr/^{90}Y$ sources. These are contained in the ISO series 1 sources, designed for dose rate uniformity over large areas. The Category VB source may be preferable in a dosimetry system designed to monitor uranium fields when a similar source is routinely used for beta dose standardization.

The exposure geometry from contact with a slab produces a different depth dose curve from the curve obtained at a distance from a point source. Present dosimeter designs may require calibration factors for occupational environments that are significantly different from the slab uranium source factors. The contractor is responsible for demonstrating that calibration obtained from the slab uranium source is appropriate. Category VC may be preferable if the occupational environment contains only limited beta energy ranges. The limited range must be identified as being closer to the energy of $^{90}Sr/^{90}Y$ or of ^{204}Tl. The contractor chooses the beta source in Category VC before initiating the test. If more than one of Categories VA, VB, and VC are chosen, the contractor may use different dose-interpretation algorithms when those same algorithms are used for specific occupational environments.

After each shipment of dosimeters is returned, the contractor determines the dose for each dosimeter and reports the doses to the performance testing laboratory. When all three rounds have been completed, the performance testing laboratory mails the results of the proficiency testing to the contractor. If the contractor does not demonstrate satisfactory performance in one or more categories during a test sequence, the laboratory will send the contractor a notice of required retesting with the test results.

For each dosimeter type, the retest sequence is as follows:

1. Categories I and II - When a contractor tests in both high-dose categories and the test result is not satisfactory in one or both, retesting in both is required. When a contractor tests in only one high-dose category and the test result is not satisfactory, retesting in that category is required. Whenever the test result is not satisfactory for a high-dose category, retesting in the corresponding protection level category (III or IV) is also required.
2. Categories III, IV, V, VI, and VII - When a contractor tests in three or fewer protection level categories and the test result is not satisfactory in one of these, the contractor must retest in all of them. A second case occurs when a contractor tests in more than three protection level categories, and the test result is not satisfactory in one of these tests. Then the contractor must retest in that category and in two additional

protection level categories for which their performance was satisfactory. The contractor will not know which two additional categories are chosen. Finally, when performance is not satisfactory in two or more protection level categories, retesting is required in all protection level categories for which accreditation is sought.

4.3 Onsite Assessment

To become accredited, a contractor must demonstrate the ability to conduct a credible personnel dosimetry program. For initial accreditation, an onsite visit is required after the performance testing has been satisfactorily completed. This visit shall assess the quality assurance, documentation, and technical aspects of the personnel dosimetry program. Appendix B contains the assessment criteria. Assessors may use them with considerable latitude according to their experience and as the unique conditions at each processing facility may dictate. The onsite assessment is repeated at least every two years.

Two assessors are assigned to visit each facility. Assignments are based on how well the assessors' individual experience matches the type of processing to be assessed. Assignments also are made to avoid conflicts of interest. The contractor is told of the assignments and has the right to appeal the assignment of an assessor to the Performance Evaluation Program Administrator. If the contractor and the Program Administrator cannot agree on an assessor, they may ask the Appeals Board to resolve the difference. When the assessors have been assigned, the Program Administrator contacts the contractor to arrange a mutually agreeable date for the visit. The field office is notified of the dates of the site visit. The time needed to conduct an onsite visit varies. A two-man team typically requires two to three days.

The assessors:

1. Begin the visit by meeting with the management and the supervisory personnel responsible for the dosimetry activities for which accreditation is being sought. The assessors acquaint management with the assessment process and set the agenda for the visit.
2. Evaluate the contractor's quality assurance system.
3. Select and trace the history of a sample batch of dosimeters from when the dosimeters are received to the time a dose report is issued.
4. Thoroughly review the contractor's performance test results.
5. Review the contractor's quality assurance documentation.
6. Examine technicians' notebooks for records about the selected group of dosimeters.
7. Check dosimeter identification and tracking procedures.
8. Determine if the appropriate environmental conditions are maintained.
9. Examine copies of completed reports.
10. Evaluate documentation.
11. Evaluate technical aspects. These include: personnel training and competency, facilities and equipment, equipment calibration and maintenance, and record-keeping systems.
12. Conduct a close-out meeting with management and supervisory personnel to explain their findings and to clarify the contractor's responsibilities.
13. Leave a copy of their reports with the contractor.
14. Conduct monitoring visits between the biennial assessments.

The following subsections discuss some of these activities. Subsections 4.3.1 through 4.3.3 provide a general overview of the program elements assessors are likely to consider important components of a satisfactory dosimetry program. Subsections 4.3.4 through 4.3.6 discuss the close-out meeting, procedures for correcting deficiencies, and monitoring visits.

4.3.1 Quality Assurance Program. The key to a properly functioning organization is an ongoing quality assurance (QA) program. A QA program is an organization's internal system of procedures and practices to ensure the quality control of its services. A QA manual should document this program. To qualify for accreditation, a contractor must demonstrate its QA program during the onsite visit. Criteria for the QA program are contained in Appendix B.

4.3.2 Documentation. A contractor must have up-to-date documentation thoroughly describing all of its significant procedures and practices. These

written descriptions should contain such items as: (a) personnel requirements and responsibilities, (b) a system for maintaining necessary records, (c) operating procedures, (d) procedures to employ in the event of unusual or nonstandard circumstances, and (e) scheduling. Written descriptions should cover at least these topics:

Personnel

- Organizational chart
- Job/position description for all dosimeter-processing and records-management personnel
- Procedures for training personnel
- Assurance of personnel competency

Equipment

- Processing-equipment inventory, including radiation sources used for calibration
- Practices for processing-equipment calibration, verification, and maintenance
- A test plan (processing protocol) for the conduct of the performance tests for each dosimeter design processed
- Instructions for operating all processing equipment, including instructions for performing operational quality assurance checks

Dosimeters

- Dosimeter models and design specifications
- Acceptance criteria for incoming dosimeter holders and materials
- Procedures for handling and storing sensitive dosimeter components and materials
- Assembly/disassembly techniques for all dosimeter models used
- Procedures for periodic checks of in-service dosimeters
- Identification and tracking of dosimeters
- Procedures for handling and storing in-service dosimeters
- Actions to repair or replace damaged dosimeters

Calibration

- Relationship(s) between dosimeter calibrations and field spectra
- Dosimeter calibration techniques and procedures, including traceability paths

Reporting

- Data handling and reporting
- Actions to be taken when variations in test data indicate a problem.

4.3.3 Technical Adequacy. Contractors must ensure employees do their jobs well by having adequate procedures for training and utilizing employees. Contractors must also provide adequate equipment, facilities, and maintenance procedures.

4.3.3.1 Personnel Training. The contractor must ensure each new staff member is trained for the processing duties assigned. The competency of staff members should be verified and documented annually. In addition, all staff members should be retrained when processing equipment and protocols are changed or when the staff members are assigned new responsibilities.

Each staff member must receive (or have had) training for the assigned duties through on-the-job training, formal classroom sessions, or a technician certification program. This training should be documented in the personnel file.

4.3.3.2 Personnel Competency. The technical director of the personnel dosimetry program should be a professional experienced in applied radiation dosimetry. He/she should be knowledgeable in the design and operation of the dosimetry system(s) currently utilized. This individual should have the technical competence to establish any required dosimetry programs. He/she should also have the supervisory capability to direct the work of professionals and technicians in the dosimetry area. The technical director may be responsible for the quality assurance program. If not, responsibility is assigned to another individual. This person should have knowledge and experience in quality assurance. He/she will communicate directly to the technical director and other organizational management. If a second individual has responsibility for the QA program, the description for that position should be included in the organization description. There should be enough trained staff members to provide program continuity.

In addition to providing for staff training, the technical director must annually evaluate the competency of each staff member authorized to perform

dosimeter evaluations. These staff evaluations should be available for review.

The DOELAP Performance Evaluation Program Administrator must be informed of any organizational or personnel changes that could affect the performance of the contractor's dosimetry program. Changes such as technical supervision or responsibility for quality assurance program should be reported to this Administrator within 60 calendar days of the change.

4.3.3.3 Facilities and Equipment. The contractor or dosimeter processor must have facilities and equipment adequate to perform the type(s) of processing for which it claims capability. Proper shielding should be provided to protect areas from unwanted radiation, and environmental controls should be maintained. The equipment should include adequate processing equipment and radiation sources. If properly calibrated (NBS-traceable) laboratory-standard equipment for determining dose equivalent is not available, the contractor should have access to the services of a competent calibration laboratory.

Adequate backup equipment or systems for key processing steps should be available for use in the event the primary systems fail. The backup system could be arranging for the services of another DOE-accredited contractor on an emergency basis.

4.3.3.4 Equipment Maintenance and Calibration. The contractor must maintain a preventive maintenance program for equipment used to process dosimeters and to perform quality control checks. When equipment—used for measurement, dosimeter processing, or quality control—is inherently subject to change due to use or the passage of time, it must be calibrated periodically. Calibration is comparing the equipment with a reference standard. This comparison determines the performance of a measuring instrument or the output of a radiation source with sufficient accuracy.

The proper performance of the dosimetry processing system must be verified periodically. Dosimeters irradiated in well-characterized radiation fields are used for this purpose.

Either the contractor or an external calibration service should calibrate equipment or the dosimetry system and characterize radiation fields. All calibrations and characterizations must be performed using reference standards traceable to NBS national standards[18] or to standards maintained by an equivalent foreign national standards authority. Being traceable means being able to show that appropriate documented actions were taken to compare (either directly or indirectly) a reference standard with a national standard.

The transfer standards used and the environmental conditions at the time of calibration must be documented for all calibrations. Calibration records must be made available for inspection during the assessors' onsite visit. The traceability of the reference standards used are verified at that time.

4.3.3.5 Recordkeeping. The contractor must maintain functional records on the dosimetry system. This means the records should be easily accessible, in some logical order, and complete. Records covering the following items are required and are reviewed during the onsite visit:

- Staff training dates and results
- Staff competency review
- Processing-equipment calibration and maintenance
- Data used to develop dosimeter processing algorithms
- Results of inspection of incoming dosimeter materials
- Logs of processing activities
- Results of internal and external equipment checks, measurement quality assurance programs, audits, etc.
- Performance test data and reports
- Tracking and logging dosimeters.

Processing-equipment calibration (or verification) records should include the following: equipment name or description; model, style, or serial number; manufacturer; notation of all equipment variables requiring calibration or verification; the range of calibration/verification; the resolution of the instrument and its allowable error; calibration or verification date and schedule; date and result of last calibration; identity of the laboratory individual or external service responsible for calibration; source of reference standard and traceability.

Dosimeter-tracking and -logging records should trace the movement of each dosimeter through the processing facility, from its receipt through all the tests performed to the final report.

The final dose report the contractor developed for the permanent record should include or reference the location of the following:

- Name and address of contractor

- Pertinent dates and identification of dosimeter, including contractor and corresponding processor identification codes
- Description and identification of the dosimeter and/or elements
- An explanation of any deviation from the protocol routinely used in processing dosimeters that may affect the reported dose (e.g., mishandling of background control dosimeters)
- Identification of anomalies
- Signature of or a reference to the person having technical responsibility
- All additional items identified in the contractor's test plan.

4.3.4 Close-Out Meeting. At the conclusion of the visit, the assessors will discuss their observations with appropriate members of management and identify any findings or deficiencies. A written summary of any deficiencies discussed is left with the contractor's authorized representative. The assessors forward the assessment forms and the written summary to the DOELAP Performance Evaluation Program Administrator for use in the technical evaluation. The contractor is requested to forward within 30 days a written plan for resolving identified deficiencies. This plan should be sent through the field office to the Performance Evaluation Program Administrator.

4.3.5 Deficiencies. Deficiencies identified during the initial onsite visit may require some time to correct. These corrections must be completed before accreditation is granted. Deficiencies noted during subsequent biennial onsite assessments of an accredited contractor should be corrected within 60 days of the close-out meeting. If a contractor disagrees with a part of the assessors' findings, the contractor may request that the Performance Evaluation Program Administrator review and reverse the findings in question. A further appeal may be directed in writing to the Appeals Board if the assessors' findings are upheld. When out-of-calibration apparatus is cited, the apparatus should not be used until corrective action has been completed. Any deficiencies noted for corrective action are reviewed during subsequent onsite visits and technical evaluations.

4.3.6 Monitoring Visits. In addition to regularly scheduled onsite assessments, assessors may be assigned to make monitoring visits at any time during the two-year accreditation period. Monitoring visits may occur for cause or on a random basis. These visits may serve to verify reported changes in the contractor's processing facilities and/or operations. The visits may also explore possible reasons for poor performance in proficiency testing. The scope of a monitoring visit may range from checking a few designated items to making a complete review.

4.4 Granting Accreditation

When the technical evaluation has been completed or at the end of the accreditation period, the Performance Evaluation Program Administrator prepares an administrative report and recommendation for the DOE Headquarters DOELAP Administrator and the Oversight Board. The Board evaluates the report and recommendation and proposes one of two options:

- **Accreditation** - The HQ DOELAP Administrator completes the accreditation process by issuing a certificate of accreditation to the contractor.
- **Remedial Action Required** - The contractor is notified that remedial action is required and of the reason(s) for the remedial action. The contractor must immediately identify and implement a remedial action plan within 45 days of receiving the notification. This plan is sent to the HQ DOELAP Administrator through the DOE field office with a copy to the Performance Evaluation Program Administrator. A contractor may request an Appeals Board review.

Dosimetry systems may be partially accredited if a system is demonstrated to be satisfactory in a particular subset of the DOELAP irradiation categories. If a system has not satisfactorily demonstrated compliance with the test criterion in a particular subset of categories and if a remedial action plan is initiated, the accreditation process may continue in all other categories.

The contractor has the responsibility to inform the Performance Evaluation Program Administrator whenever any changes are made in dosimeters or processing techniques. The contractor must provide evidence supporting a conclusion that the system is technically equivalent to the accredited system. The Performance Evaluation Program Administrator with the Oversight Board's approval makes a determination of technical equivalence. If they decide the

changed dosimeters or techniques are not technically equivalent, the accreditation does not cover the dosimeters or techniques. They must be fully evaluated and/or demonstrate a satisfactory dosimeter performance in accordance with DOELAP requirements before they are covered.

If a change in the type or quality of radiation fields occurs, or is anticipated, the contractor shall inform the Performance Evaluation Program Administrator. The contractor shall also justify either that the existing accreditation is adequate, or that additional accreditation testing is required. The Performance Evaluation Program Administrator will recommend approval or disapproval. The justification with the recommendation is forwarded to the Oversight Board for action. The contractor may request a review of the results by the Appeals Board. If the current dosimetry system is not adequate, the contractor may: (a) apply to accredit either the current system, a new system, or a supplemental system including the new radiation field(s), or (b) obtain dosimetry services from a DOE contractor currently accredited for the radiation field(s) involved.

5. EXCEPTIONS

DOELAP excepts some B-Clause contractors from these requirements. These B-Clause contractors do not perform in-house dosimetry and do not routinely report significant doses received by personnel (e.g., small university contracts). In these cases, the B-Clause contractor may choose to obtain accreditation from either DOELAP or NVLAP. Field offices may apply for additional exceptions to the HQ DOELAP Administrator.

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APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

1. DOE site or facility _____

2. DOE Field Office _____

3. Other DOE facilities using your personnel dosimetry services (specify dosimeter designs and applicable categories required). _____

_____

_____

4. Vendor identification, if outside vendor used:

_____

_____

_____

5. Name of authorized representative of management for DOELAP accreditation

Name _____

Title _____

Department _____

Contractor _____

Address _____
Street or P.O. Box City State Zip Code

Telephone _____

6. List all dosimeters, by name and model number, for which accreditation is sought and place an (x) under each dosimeter listed, opposite the appropriate category (see DOELAP Handbook and DOE Standard for a detailed explanation of each category).

Category		Dosimeter Designation
I.	Low-Energy Photon[a] (High Dose)	
II.	High-Energy Photon[b] (High Dose)	
IIIA.	Low-Energy Photon	
IIIB.	Low-Energy Photon (Plutonium)	
IV.	High-Energy Photon	
VA.	Beta	
VB.	Beta (Uranium)	
VC.	Beta (Special)[c]	
VI.	Neutron[d]	

a. Automatically entered if entered in Category IIIA or IIIB.

b. Automatically entered if entered in Category IV.

c. Please specify whether a high energy beta source ($^{90}Sr/^{90}Y$) or a low energy beta source (^{204}Tl) more nearly approximates the beta spectra of your facility.

d. Please specify one or both of the neutron sources. Use only the source(s) that more closely represent the energy spectra found in the occupational environments covered by your service. If the energy spectra vary significantly, both sources may be necessary.

NOTE: If a dosimeter is entered in two or more single categories (III-VI), it is automatically entered into all of the appropriate mixture categories (VII). A combination dosimeter with physically separate parts should be listed as one dosimeter. A separate neutron dosimeter should be considered part of a general beta-gamma-neutron dosimeter and submitted together with the beta-gamma dosimeter to the neutron/photon mixture categories. The Performance Evaluation Program Administrator will inform you of the required number of dosimeters to be submitted for each of the three irradiation periods.

7. Which of the dosimeters listed in the table above are currently in use? Planned for future use? Under study? (No additional information is required for dosimeters under study.)

8. For each dosimeter listed in the preceding table, describe important design features, including: type of dosimeter material, type of badge or dosimeter holder used, dosimeter placement inside the holder, and type and arrangement of absorbers. Diagrams are helpful. (Proprietary information should not be included.)

9. For each dosimetry system listed in the table, attach a short statement to justify not seeking accreditation in any of the listed categories.

10. For each dosimeter, state whether it is processed in-house, in a commercial laboratory, or in another government facility.

11. Describe in-house dosimeter processing, including readout apparatus and procedures and protocols for the handling, storage, and preparation of dosimeters. Indicate whether processing is manual or automatic. Indicate procedures that may differ for different categories.

12. If an angular dependence study of dosimeter performance and a determination of the lower limit of detectability have been performed, results should be included with this application. If not, results will be required prior to the granting of accreditation (see DOE Standard for the Performance Testing of Personnel Dosimetry Systems).

13. If field calibrations of dosimeters are used to determine occupational exposures, the dosimeter calibration documentation for each field type should be included with this application.

I hereby authorize this application and attest that all statements made are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

Authorized Representative:

Printed Name _____

Signature _____

Title _____

Date _____

By authorizing this application you affirm that you are aware that if accreditation is granted to your organization, the accreditation applies to dosimetry processing services using the specific dosimeter models/types in the categories requested and using the processing techniques that were used to demonstrate satisfactory performance in accordance with the DOE Standard. You will be expected to use the same dosimeter(s) and techniques in the normal processing activities you perform.

If any changes are made or deviations occur in these dosimeters or techniques, it will be the responsibility of your organization to provide evidence that such changes lead to results that are technically equivalent to the accredited processing activities. Determination of technical equivalence will be made by the DOE Oversight Board.

If the changes or deviations to the dosimeters or processing techniques are not considered to provide results that are technically equivalent, the new dosimeters and/or techniques will not be covered by the accreditation until they have been fully evaluated and/or their performance has been demonstrated in accordance with the DOE Standard.

In authorizing this application you declare that you commit the applicant contractor to:

- Be examined and audited, initially and on a continuing basis during the accreditation period
- Permit the onsite assessors to review and examine records or other documents required by the DOELAP Handbook
- Maintain compliance with applicable handbook criteria
- Participate in proficiency testing programs that may be required for maintaining accreditation.
  Field Office Review: (to be completed before application is submitted)

Printed Name _____

Signature _____

Title _____

Date _____

APPENDIX B

CRITERIA FOR ONSITE ASSESSMENT

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CRITERIA FOR ONSITE ASSESSMENT

The site assessors are given considerable latitude in evaluating a contractor's personnel dosimetry program. To help each contractor receive a fair assessment, the assessors are provided with this list of criteria covering the main points of a good program.

General

The contractor shall have the latest versions of the processing protocols, dosimeter specifications, quality assurance manual, and other related documents (equipment manufacturer instructions, etc.) available at the facility. The latest version of these documents must be used in conducting all routine processing.

Personnel

1. The functional organization must be consistent with the current organizational chart for the personnel dosimetry program.
2. The qualifications of the individual who has technical responsibility for the personnel dosimetry program must be consistent with the position description.
3. The individual who has technical responsibility must generally exhibit adequate technical knowledge and management control for personnel dosimetry.
4. The individual who has technical responsibility must ensure all dosimetry data are approved.
5. The qualifications of the individual responsible for personnel dosimetry quality assurance (QA) must be consistent with the position description.
6. The responsibility for maintaining and revising the QA manual must be clearly assigned.
7. All personnel dosimetry program staff members must be familiar with and implement the documented quality control program.
8. Communication between technical and supervisory staff members must be adequate.
9. An independent organizational relationship must exist between dosimeter processing and other contractor activities.
10. A designated individual must exercise the authority to assign processing tasks and to ensure timely dosimeter processing.
11. The responsibility for major equipment maintenance, calibration, and servicing major equipment must be clearly assigned.
12. Assigned staff members must be knowledgeable about dosimeter processing equipment and competent in performing assigned processing tasks.
13. The QA manual must describe practices for ensuring staff member competency.
14. The QA manual must describe the training program to prepare staff members to conduct processing protocols.
15. The QA manual must have provisions for retraining assigned staff members when protocols are revised.
16. The competency of staff members should be verified annually, through one or both of these methods:
    - Observation of the conduct of processing protocols by technically qualified individuals
    - Written examination based on the processing protocols.
17. A record of the dates and findings of competency reviews must be available for review.
18. Specialized skills required to conduct all processing protocols must be documented. The training program for individuals who conduct the protocols must include these skills. In addition, the training must include:
    - A period of close supervision until competency is demonstrated
    - A mechanism to evaluate and inform staff members of the adequacy of their performance in conducting assigned processing protocols
    - A mechanism to retrain periodically and to correct any deficiencies in performance between the retrainings.
19. Agreement between assigned processing responsibilities and the technical areas

addressed in the training program must be apparent.

20. A record of training courses completed by each staff member must be available for review.

Equipment and Facilities

1. A list and description of the facilities and equipment used in all the processing protocols for which accreditation is requested must be available in the laboratory. The list allows the facilities and equipment to be correlated with calibration records.
2. Dosimetry readout equipment appropriate for the dosimetry system must be available.
3. When an annealing oven or furnace is necessary, it must be reserved strictly for dosimeter annealing.
4. There must be a method for securing and maintaining the resources required for the processing activities for which accreditation is requested.
5. Procedures should be established to bring backup equipment into routine service, repair equipment on a rapid-response basis, and/or use the services of another DOELAP-accredited contractor. Such procedures ensure continuity of service when personnel or dosimetry systems fail to perform within the control limits.
6. Dosimetry processing equipment must be identified well enough to permit correlation with calibration records.
7. Adequate controls must be in place to ensure equipment performance at the levels of precision and accuracy the contractor defined in each processing protocol. The operating procedures to be implemented when the equipment fails to meet these criteria must be documented.
8. To help evaluate the stability of equipment performance, records of preventive maintenance and repairs must be available for each piece of processing equipment.
9. Service contracts or an in-house capability to maintain equipment and stock parts must be adequate to ensure continuity of equipment operation.
10. Environmental parameters in the processing facility, including background radiation, must be measured and recorded.
11. Calibration and verification records for major equipment used in dosimetry processing must include
    - Equipment name or description
    - Manufacturer's name
    - Model, style, serial number, or other identifying mark
    - Identification of all equipment variables requiring calibration or verification
    - Range of dose measurements for calibrations
    - Allowable error (taking into consideration instrument tolerance) to coincide with the requirements of each processing protocol
    - Schedule for periodic calibrations, including calibration/verification date
    - Date and result of last calibration/verification, including assessed uncertainty of measurement
    - Identification of staff member or position responsible for equipment calibration, or identity of external service performing calibration
    - Identity of reference standard and how the individual dosimetry data relate to national standards or to nationally accepted measurement systems.
12. The calibration of equipment must be verified at regular intervals. These intervals are determined by equipment type, manufacturing specifications, accumulated stability data, or some other reasonable plan. In all cases, the processor must demonstrate the reliability of the measurements performed.
13. Duties are assigned for all processing equipment maintenance and for routinely verifying all equipment is in proper working order.

Quality Assurance

1. Technicians must be familiar with and implement the documented quality control program.
2. The quality control program must be organized to assess the variability of test results among staff members.
3. The supervisor must examine audit results. Action must be taken to correct any deficiencies.
4. Records of the laboratory's participation in intercomparison programs or external measurement assurance programs must be consistent with practices defined in the QA manual.

5. If processing is conducted in multiple locations within the processor's facility, the processor must perform comparative tests to assess the consistency of dosimetry data.
6. The documented QA system must clearly describe records kept and practices followed. These records and practices must cover the process from the point of dosimeter receipt through to the final delivery of data to the user.
7. Records of any deviation from the use of documented processing procedures, equipment, or facilities must be kept to show no degradation of performance occurred.
8. The QA program must incorporate external checks, including:
   - Processing controls (e.g., light source readings, microprocessor controls)
   - Blind-audit dosimeters
   - Unexposed dosimeters.
9. A comprehensive record of processing activities (i.e., a dated log) must be maintained. This record must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.

Dosimeters

General Criteria

1. Practices for receiving, handling, and storing dosimeters must be consistent with provisions in the QA manual.
2. A positive system for identifying and tracking all dosimeters must be in use.
3. A satisfactory acceptance criterion for all dosimetry material must be established. The criteria must be documented in the QA manual.
4. Sufficient information must be contained in the dosimeter identification code to allow correlation with the record system used in processing.
5. The dosimetry system documentation must include a design specification. The specification must show the minimum and maximum exposure level the dosimeter can record during routine processing.
6. A procedure for checking the proper assembly of dosimeter cards and/or film packets must be documented.
7. Documented procedures must be used to verify:
   - Filter materials are consistent with the dosimeter design
   - Filters are properly placed in dosimeters.
8. A procedure must be established to verify dosimeter holders meet required specifications.
9. The QA manual must document procedures for handling dosimeters before they are issued.
10. Dosimeters placed in service must be checked according to a defined schedule or frequency to ensure all necessary components are in place.
11. A screening procedure must be used to ensure that dosimetry materials (sensitive elements) are consistent with the dosimeter design. The procedure must include phosphor type and sensitivity.
12. The identification system must be adequate to ensure the correct identification of both demountable (nonfixed) and fixed thermoluminescent (TL) elements. The system must also identify the association of each TL element with a position or filter in the dosimeter.
13. The same dosimeter type or model and sensitive elements used during proficiency testing must be used to assess occupational exposures.
14. Information available concerning processed dosimeters should include:
   - Radiation type
   - Dose definition (terminology)
   - Responsibility for handling the dose of record
   - Calibration procedures used in dose determination
   - Quality control
   - Special processing procedures to be used as part of the dosimetry service
   - Directions for handling and using background control dosimeters
   - Identifying anomalies noted during processing.
15. A person must be assigned responsibility for the receipt of in-service and background control dosimeters. There must also be a proced re to cover this. The procedure must include:
   - The individual dosimeter identification, the dosimeter type, and the appropriate processing protocol to be followed
   - Identifying and coding internal and external control dosimeters
   - A mechanism for tracking an individual dosimeter and/or sensitive element through the processing cycle

- A mechanism for identifying dosimeters that have not been returned by clients for processing
- A method for screening dosimeters or TL elements for significant contamination prior to readout
- A method for identifying mishandled background control dosimeters.

16. The location of dosimeters within the laboratory must be documented.
17. Environmental parameters, including background radiation, must be monitored in dosimeter storage areas to ensure adequate storage conditions.

Thermoluminescence Dosimeters (TLDs)

1. Equipment for reading out and annealing TL elements must be appropriate for the system.
2. A written procedure must exist and responsibility must be designated for establishing and checking appropriate instrumentation operating conditions. This check may include the following:
   - Reproducible positioning of the TL element in the reader
   - Stabilization against voltage change or drift in dark current when applicable
   - Reproducible heating cycle that ensures readout of a consistent fraction of relevant stored energy
   - Glow curve output
   - Inert-gas purging
   - Digital readout.
3. A method for removing sensitive elements from the dosimeter case must be documented and implemented. The method must preclude losing information from the sensitive element.
4. The operation and stability of TLD readers must be checked at least daily using preexposed dosimeters or light sources. Records must indicate that no dose measurements are made until equipment conditions have stabilized.
5. Sufficient measurements must have been made to establish the relationship between the TL emission-dose characteristics and the conversion factor. The conversion factor is used to convert instrument reading to dose equivalent.
6. Technicians must understand operating conditions and critical functions of TLD processing equipment, including:
   - Heating/temperature cycle
   - Inert-gas purging
   - Annealing cycle
   - Recognition and resolution of equipment failure.
7. Procedures for loading and unloading the TL reader must be implemented as documented.
8. The processing protocol must include reviewing selected dosimetry data during the readout cycle.
9. Before they are issued, TLDs or phosphors must be subject to an adequate annealing cycle. The annealing cycle must be reproducible regarding time, temperature, cooling rate, humidity, and light.
10. Background readings must be checked according to an established procedure before TLDs are issued.
11. Precautions must be taken to minimize the exposure of light-sensitive TL materials to light.
12. Precautions must be taken to avoid the contamination of TL elements (e.g., by chalk, dust, grease, or any radioactive material).
13. Loading sensitive elements must be carried out in a well-defined order. Loading procedures must prevent confusion in handling visually-similar elements of different TL materials and contamination of TL material in powder form.
14. To prevent damage or unknown exposure during transit, TLDs must be suitably packaged for issue to users.
15. TL material fading under normal conditions must be documented and accounted for over the period of intended use.
16. The TL material for each dosimeter type or model must be capable of withstanding heat treatment required in the dosimetry process.

Film Dosimeters

1. An acceptance procedure must be in place to verify film as received meets the manufacturer's specifications. It must further verify the film's expiration date is beyond the anticipated time of use and processing.
2. Equipment, facilities, and materials must be adequate to support the film processing operations for which accreditation has been requested.
3. Film-processing darkroom(s) must be temperature-controlled and have properly installed safelights. They must either use incandescent lights or be able to demonstrate nonincandescent lights do not affect the dosimeter results.

4. Safelights used in darkrooms must be tested at prescribed intervals. Testing shall measure the fog level of exposed films. Exposure shall be at the normal working distance from the safelights for a period comparable to the maximum processing time.
5. Precautions must be taken to prevent accidentally exposing the films to light while they are being processed.
6. Processing chemicals must be dated and properly stored. A procedure must exist for their disposal when their shelf life expires.
7. Tanks and equipment that hold or are exposed to processing solutions must be chemically inert.
8. The equipment must be capable of measuring film densities equivalent to an optical density of 0.01 to 5. Resolution shall be ±10% or ±0.01 density units, whichever is greater, and the equipment must be adequate to support the workload.
9. Records must demonstrate the accuracy and reliability of all instruments used to determine the gross density of specimen and control films.
    - Densitometer performance must be checked for consistency before use.
    - Densitometers must be calibrated at the most frequent of these three intervals:
        - As the manufacturer recommends
        - Biannually
        - As directed in the processing protocol.
10. Films must be removed in the darkroom and loaded in identifiable order in film racks for processing.
11. Through quality control films, the dose density characteristics of each film emulsion batch must be established. A known relationship with the master algorithm for the dosimeter model must also be established.
12. Quality control films of the same emulsion lot must be included in each processed batch. The quality control films should be exposed to known doses that adequately check the response curve of the dosimeter type. They must be positioned at the beginning and end of each processing batch and at intervals as defined in the processing protocol.
13. At least two unexposed films of the same emulsion lot must be included in each processed batch.
14. Processing control films must be verified as meeting control limits before routine processing activities are initiated.
15. As a minimum, the contractor must follow the film manufacturer's recommendations when adopting chemistry and processing conditions in the processing protocols.
16. Before it is issued, film must be stored unopened. The storage location must be cool, dry, free from chemical vapors or other deleterious agents, and have low background radiation.
17. Film must be current. It must be stored so as to reduce buildup of density due to natural background radiation and/or deterioration with age.
18. Before film is issued, its emulsion lot number must be noted and each lot must be tested. Testing shall check that the fog level, dose density, and spectral characteristics are satisfactory.
19. To prevent damage or unknown exposure during transit, film dosimeters must be suitably packaged for issue to users.
20. Records must show that temperatures and times for development, stop bath, fixing, washing, and drying are reproducible and consistent with processing protocols.
21. Developer/fixer solutions must be kept covered to reduce oxidation and exclude contamination.
22. During development, the developing solution must be agitated to provide for the uniform development of all film.
23. Procedures must be documented and followed to allow the appropriate time lapse between preparing developer and fixer solutions and using them. They must also document and follow the time lapse for discarding or replenishing these solutions according to how long they are used or how many films are processed.
24. If a stop bath is used, procedures must be documented and followed for using and renewing it.
25. Fixing procedures must be documented. They shall be implemented according to the manufacturer's recommendations.
26. Washing procedures after fixing must be as documented.
27. The temperature difference in adjacent processing solutions must not exceed 3°C.
28. Records must indicate the apparatus used to dry film does not exceed the appropriate drying temperatures. Drying temperatures must be documented in the processing protocol.

29. After processing, films must be stored so they may be retrieved without damage to the emulsion.
30. Films must be examined for nonuniform blackening. A special measurement procedure must be defined for those showing significant nonuniform blackening.
31. All measurements made must be recorded with film identification codes.
32. Track detectors must be evaluated using optical or counting equipment appropriate for the anticipated macro- or microscopic track dimension.

Calibration

1. Calibration and verification practices for dosimetry systems must be outlined in the QA manual. The manual must identify the calibration services, reference materials, and measurement assurance programs used.
2. Dosimetry systems must be calibrated to known doses from radioactive sources or radiation-generating machines. The calibration facility radiation fields must be measured with calibrated instruments. Instrument calibrations must be traceable to national standards or based on the measurement of activity of a source. In the latter case, the source must be traceable to primary radiation standards. Care must be taken to maintain a standard source geometry.
3. Calibration protocols used must be appropriate for the sources of radiation at the facility and the potential exposure levels.
4. The energy response of each type or model of dosimeter must be characterized by calibrating each model for all appropriate radiation categories. The dosimeter response must be determined over the exposure range for which it is to be used.

Processing

1. The processing protocol must be documented in sufficient detail that it can be followed by a competent technician.
2. All processing personnel must adhere to processing procedures defined in processing protocols.
3. A comprehensive record of processing activities (i.e., a dated log) must be maintained. The log must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.
4. When any deviation from using documented processing procedures, equipment, or facilities occurs, records must show performance remained satisfactory during the period in which the deviation occurred.
5. The individual technically responsible for dosimetry processing or his/her assigned representative must give final approval of dosimetry data. This person must also make decisions regarding questionable data.
6. The algorithm must be satisfactorily documented to indicate its validity for dose interpretation. Documentation must indicate:
   - The algorithm was created and tested using fundamental data that are retrievable.
   - The uncertainty analysis of the algorithm characterizes the precision and accuracy of the dose interpretation to the dosimeter.
   - Process controls were considered and documented when the algorithm was developed.
   - The attributes and limitations of the algorithm are documented.
7. Computational models or algorithms for calculating dose from raw data must be adequate for the processor's dosimetry system.
8. All processing protocols must be audited to ensure no degradation of performance occurs.
9. Each processing protocol must provide for interspersing quality control dosimeters. These dosimeters must have a predetermined relationship to the primary calibration dosimeters as follows:
   - Suitable sources must be used to irradiate the quality control dosimeters.
   - Records must indicate good reproducibility for the irradiation method.
   - Evaluation of the quality control data must be outside the control of the processing technician.
   - The contractor must have determined how frequently blank and quality control dosimeters shall be used. This determination must be based upon the total number of dosimeters processed, equipment stability, the type of quality control checks used, or other suitable means.
10. The dose of quality control dosimeters must be determined either from measurements using a transfer-standard quality instrument or by

calibration from a source of known activity. Instrument calibration and the activity of the source must be directly traceable to primary standards.

11. A procedure must exist for a detailed review of data produced between the last successful quality control dosimeter and the first quality control dosimeter failing to meet control limits.
12. Dose measurements must be identified and recorded at the time of measurement.
13. The useful dose range for the dosimetry system must be established and documented in each radiation category of interest.
14. Control limits to accept dose measurement data from in-service dosimeters must be defined and implemented.
15. The technical director or a designee must review dosimeter data for anomalies before reporting the dose.

Reports

1. The QA manual must outline practices for handling and resolving contested dosimetry data and test reports.
2. The dose report must include:
   - Name and address of processor, if different from contractor
   - Name of contractor
   - Pertinent dates and the identification of dosimeters, including processor and contractor identification codes, if appropriate
   - An explanation of any deviation from routine processing procedures if the deviation could affect the reported dose
   - The signature of or a reference to the person having technical responsibility.

Testing

1. Protocols for proficiency testing in accordance with the DOE Standard must be defined. They must be consistent with routine processing procedures.
2. A written test plan for each radiation category for which accreditation is sought must be available to the processing staff.

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DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health
Washington, D.C. 20545

FOREWORD

This standard is intended to be used in the Department of Energy Laboratory Accreditation Program (DOELAP) for personnel dosimetry systems. It is based on the American National Standards Institute's (ANSI) *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11-1983,[1] recommendations made to DOE in *Guidelines for the Calibration of Personnel Dosimeters*, Pacific Northwest Laboratory (PNL)-4515[2] and comments received during peer review by DOE and DOE contractor personnel. The recommendations contained in PNL-4515 were based on an evaluation of ANSI N13.11 conducted for the Office of Nuclear Safety, DOE, by PNL.[3] Parts of ANSI N13.11 that did not require modification were used essentially intact in this standard to maintain consistency with nationally recognized standards.

Modifications to this standard have resulted from several DOE/DOE contractor reviews and a pilot testing session. An initial peer review by selected DOE and DOE contractor representatives on technical content was conducted in 1983. A review by DOE field offices, program offices, and contractors was conducted in mid-1984. A pilot performance testing session sponsored by the Office of Nuclear Safety was conducted in early 1985 by the Radiological and Environmental Sciences Laboratory, Idaho Falls.[4] Results of the pilot test were reviewed in late 1985 by a DOE and DOE contractor committee.

The DOE Laboratory Accreditation Program provides a structured means for assuring the quality of personnel dosimetry performance. The program was initiated and developed by the DOE Office of Nuclear Safety (Environment, Safety and Health) to improve the quality of personnel dosimetry through (1) performance testing, (2) dosimetry and calibration intercomparisons, and (3) applied research.

Participation in the program is required of all DOE and DOE contractor dosimetry programs (DOE Order 5480 Series). Further information with respect to the requirements and administration of DOELAP program is provided in the "Handbook for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" and the "Quality Assurance Manual for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" (applicable to the Performance Test Laboratory only).

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DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

1.1 Purpose

This standard defines a set of reference performance tests to help establish a uniform approach to personnel dosimetry. The purpose of the standard is to describe minimum levels of acceptable performance and to provide procedures for the performance testing of personnel dosimetry systems.

1.2 Scope

The standard applies only to personnel dosimetry systems used for determining whole-body dose equivalent for the permanent record. The standard is applicable for dosimetry performed for health protection under controlled and uncontrolled conditions (accident dosimetry). Tests for accident dosimetry are approximately represented by the high-dose categories. The performance testing includes categories for the determination of dose equivalent (or absorbed dose) due to ionizing radiation only.

The standard also applies for specific energy intervals. The approximate intervals are from 15 keV to 2 MeV for photons, above 0.3 MeV (average energy) for beta particles, and from 1 keV to 2 MeV for neutrons.

Performance studies for angular dependence (Section 3.3) and lower limit of detectability (Section 3.4) are required one time only for each dosimeter type submitted for evaluation.

NOTE: Performance tests for extremity dosimetry, thermal neutron dosimetry and high-energy neutron dosimetry are excluded from this scope. These categories are planned for inclusion in future revisions of this standard.

1.3 Use

Reference calibration points for personnel dosimetry systems, including energies, source specifications and standard irradiation geometries are defined in sections 2.2, 2.3, and 2.4. The performance criteria defined in section 3.1 shall be used to evaluate dosimeter performance at each reference energy.

Calibrations used for the evaluation of occupational doses or dose equivalents may differ from the reference calibrations. Where such differences exist, the dosimeter's response per unit of delivered dose (or dose equivalent) for the calibration applicable to the occupational environment shall be determined relative to a reference calibration point. Determinations of calibrations specific to occupational environments shall be documented.

A facility should not be required to comply with all portions of this standard if a technical basis for exemption from identified categories is demonstrated.

1.4 Review

The standard shall be reviewed and updated by the Department of Energy (DOE) when considered necessary. Technological advances in both beta and neutron personnel dosimetry practices may allow strengthening of the performance specifications. In addition, it may be desirable to broaden the scope of the standard.

1.5 Definitions

The definitions for many of the terms used in this standard are given below:

Absorbed Dose (D). The energy absorbed per unit mass at a specified point. The special unit is the rad. The SI unit is the gray (Gy). 1 Gy = 100 rad.

Accident Dosimetry. The determination of high levels of absorbed dose resulting from uncontrolled conditions.

Accreditation. The process of evaluating a program which uses personnel dosimeters to measure, report, and record dose equivalents received by radiation workers.

Angular Dependence. The response of a dosimeter as a function of angle of incidence of the radiation detected compared to its response at normal incidence (nonperpendicular incidence).

Applicant. A DOE or DOE laboratory contractor facility which has submitted an application for DOELAP accreditation and is participating in the accreditation process. The dosimetry processor may be the same as the applicant or may be under contract to the applicant to provide the processing service.

Bias (B). The average of the performance quotients, P_i for n dosimeters, for a specified irradiation category and depth,

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1)$$

Calibration Specific to Occupational Environment. The dosimeter calibration applicable only to a particular occupational environment. These calibrations are determined by comparing reference measurements to dosimeter response measurements. Both measurements are performed in the work place.

Detection Threshold. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the mean readout value of unirradiated dosimeters.

Dose Equivalent (H). The product of the absorbed dose (D), the quality factor (Q), and any other modifying factors. The special unit is the rem. When D is expressed in Gy, H is in Sieverts (Sv). 1 Sv = 100 rem.

Dosimeter. A combination of absorber(s) and radiation-sensitive element(s) that is used to provide a cumulative record of absorbed dose or dose equivalent received when worn by an individual.

Estimate of Uncertainty (E). The estimated fractional uncertainty of the delivered dose or dose equivalent. The value excludes uncertainties associated with the exposure-to-dose-equivalent conversion factors for photon irradiations, the flux-to-dose equivalent conversion factor for neutron irradiations and the photon component of the neutron irradiations. The testing laboratory calculates this value.

Exposure-to-Dose-Equivalent Conversion Factor for Photons (C_x). The numerical quantity that relates the exposure in air to the dose equivalent at a specified depth in a material of specified geometry and composition. The C_x factors change as a function of photon energy, material geometry (e.g., sphere, slab, or torso), and material composition (e.g., tissue-equivalent plastic, soft tissue ignoring trace elements, or soft tissue including trace elements).

Free-Field Dose Equivalent. The dose equivalent assigned for neutron irradiation as if it were performed in free space with no background due to air and room scattering and no source asymmetry.[5]

High-Dose Range. A performance test range outside the normal operating range. Tests for accident dosimetry capability are conducted within this range.

In-Phantom Dose Rate for Beta Sources. The absorbed dose rate at the specified depth inside a tissue-equivalent phantom. Phantom dimensions are assumed to be 30 cm x 30 cm x 5 cm (or greater). The tissue equivalency is for beta radiations.

Irradiation Category. Each type and energy (or mixture) of radiation for which performance criteria are given.

Lower Limit of Detectability. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the readout value at the detection threshold.

Performance Quotient (P_i). The fractional difference between the reported and delivered absorbed dose or dose equivalent for the i^{th} dosimeter.

$$P_i = \frac{[X_i(\text{reported}) - X_i(\text{delivered})]}{X_i(\text{delivered})} \qquad (2)$$

where D_d, H_s, or H_d can be inserted for X. Here d and s refer to the depth at which D or H is specified, d for deep and s for shallow. The shallow absorbed dose, D_s, is not used in the performance criteria.

Processor. A supplier of personnel dosimetry services. These services include:

- Furnishing dosimeters to the user
- Evaluating the dosimeter readings after their return, in terms of the shallow and deep dose equivalent or the deep absorbed dose as prescribed in this standard
- Recording the results
- Reporting the results to the user.

Protection Dosimetry. Routine measurements and the estimation of the dose equivalent for the purpose of determining and controlling the dose equivalent received by radiation workers.

Shallow and Deep Absorbed Dose (D_s and D_d) or Dose Equivalent (H_s and H_d). The absorbed dose or dose equivalent at the respective depths of 0.007 cm and 1.0 cm in a material of specified geometry and composition

Standard Deviation (S). The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth,

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)_2}{n-1}\right]^{1/2} \qquad (3)$$

Test. A procedure with the following sequence:

- Applicant submits dosimeters from current stock to a testing laboratory over a period of several months. The number of dosimeters submitted is sufficient for the specified irradiations in a given test category.
- Testing laboratory personnel irradiate the dosimeters using the type(s) of radiation specified for the test category.
- Applicant evaluates the response of the returned dosimeters in terms of shallow and deep dose equivalent for tests of protection monitoring or in terms of deep absorbed dose for tests in high-dose categories.
- Applicant submits these data to the testing laboratory.
- Testing laboratory analyzes the submitted data.
- Testing laboratory reports the results of this analysis (also referred to as "the test results") to the applicant.

Testing Laboratory. A laboratory independent of the applicant's operation, authorized by DOE to carry out the procedures outlined in this standard.

The words *shall*, *should*, and *may* are used as follows in this standard: *shall* denotes a requirement; *should*, a recommendation; and *may*, a permissible practice.

2. TEST PROCEDURES

2.1 Administrative Procedures

The performance tests are administered by the testing laboratory. The administrative procedures are described below.

2.1.1 Information to be Supplied to the Testing Laboratory. The applicant for accreditation shall provide the following:

- The test categories desired with justification(s) for those categories not chosen
- A brief description of dosimeter design, construction, and processing
- An indication of whether the dosimeter is in current use or planned for future use
- Angular-response data required in Section 3.3 and lower limit of detectability data required in Section 3.4 or a plan indicating how these data will be obtained and furnished to the testing laboratory
- Documentation of field calibrations if different from reference sources. The differences between the procedure, calculation, and/or calibration used for reporting occupational exposures shall be provided prior to the test procedure or along with the reported data.

The applicant shall certify that the dosimeters submitted for each test are representative of those supplied routinely to its users.

2.1.2 Number of Test Dosimeters. The applicant shall submit to the testing laboratory either 15 or 30 dosimeters for irradiation in any given test category. Submittal of 30 dosimeters requires a special arrangement with the testing laboratory (see Section 3.1). The dosimeters shall be submitted to the testing laboratory in three shipments. Additional dosimeters shall be included with each dosimeter shipment to serve as shipment controls and replacement spares. Dosimeters may be voided in a test category because of problems caused by the testing laboratory, the applicant, or the processor. The minimum number of irradiated dosimeters required for analysis of a 15-dosimeter test is 13 and for a 30-dosimeter test is 26. If this requirement is not satisfied, statistical analysis of the results in that category shall be delayed until replacement dosimeters have been submitted to the testing laboratory, irradiated, and the results are reported by the applicant to the testing laboratory.

2.1.3 Test Schedule. Each test shall extend over a period ranging from 3 to 6 months. The test dosimeters required for each test category shall be submitted to the testing laboratory in at least three separate groups as the testing laboratory directs. Each group shall be returned by the testing laboratory to the applicant within approximately 1 month of the announced start date for irradiations. Dosimeters submitted late may be included in the following month's irradiations. The applicant shall report the evaluations to the testing laboratory within 45 days of receiving the dosimeters. If this requirement is not met, it may be necessary to void all dosimeter evaluations in the same test category.

2.1.4 Dissemination of Test Results. The testing laboratory shall report all test results to the applicant after the test is completed. An estimate of the uncertainty of the assigned values of the delivered dose equivalent (or absorbed dose) shall be included in the report. The applicant shall not be permitted to change or void the reported values after receiving the test results from the testing laboratory.

2.2 Radiation Sources

The specified irradiations represent the minimum necessary to ensure adequate performance for a multipurpose personnel dosimetry system. Most of the irradiation categories specified and the range of dose equivalents were taken from the American National Standards Institute report ANSI N13.11-1983.[1]

The specifications for the test irradiations closely follow those given in ANSI N13.11. Major differences are: 1) the exposure-to-dose-equivalent conversion factors for photons (C_x) are specified for the calibration geometry; 2) the specifications for the beta source calibrations are more complete; and 3) additional photon, beta, and neutron sources are included. A more comprehensive discussion is presented in Appendix A.

The response of the personnel dosimetry system shall be determined using the following sources:

1. A sealed ^{137}Cs gamma-ray source

   - The irradiation geometry must be adjusted to achieve a shallow depth C_x factor of 1.03 ± 0.05 rem/R.

2. X-ray machine(s) that produce continuous spectra using the U.S. National Bureau of Standards (NBS) techniques[6] and are capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV)

   - The operable voltage range is between 30 kV and 160 kV constant potential for the NBS techniques (Table 1). The half-value layer and homogeneity coefficient shall be adjusted to match NBS specifications according to the recommendations in ISO 4037.[7] The half-value layers shall agree to within 2% and the homogeneity coefficients within 4% of the NBS specifications.
   - An ^{241}Am source may be substituted for the 55-keV to 65-keV nearly monoenergetic beam at the discretion of the testing laboratory.
   - The k-fluorescence x-ray technique may be used to generate the nearly monoenergetic beams.[7-9]

3. A sealed $^{90}Sr/^{90}Y$ beta-particle source with 100-mg/cm^2 filtration (nominal) to remove the ^{90}Sr component. It shall meet the following specifications:

Table 1. Reference sources

Source	Energy
Low-Energy Photons	
NBS Filtered Techniques[a]	
M30 (LG)[b]	20 keV (average)
S60 (MFC)[b]	36 keV (average)
M150 (MFI)[b]	70 keV (average)
H150 (HFG)	120 keV (effective)
Monoenergetic[c]	15 to 20 keV
Monoenergetic[c]	55 to 65 keV
^{241}Am[c,d]	59 keV
High-Energy Photons	
^{137}Cs[b]	662 keV
Beta Particles	
^{204}Tl	0.76 MeV (maximum)
$^{90}Sr/^{90}Y$ (filtered)[b]	2.3 MeV (maximum)
Natural or Depleted Uranium[c]	2.3 MeV (maximum)
Neutrons	
^{252}Cf (moderated)[b,e]	
^{252}Cf (unmoderated)	

a. NBS Special Publication 250, Appendix C.[6] The half-value layer and homogeneity coefficient should be adjusted according to the recommendations in ISO 4037.[7]

b. These sources are also specified in ANSI N13.11-1983.[1]

c. These sources were included for specific occupational environments.

d. At the option of the testing laboratory, the ^{241}Am source may be substituted for the 55- to 65-keV monoenergetic source.

e. Moderated by 15 cm of D_2O.[11]

- The residual maximum energy, as defined in the International Standard ISO 6980,[10] shall equal or exceed 1.80 MeV.
- The in-phantom dose rate at 100 mg/cm² divided by the dose rate at 7 mg/cm² shall be 1.01 ± 0.03.
- The in-phantom dose rate at 1000 mg/cm² shall be less than 1% of the dose rate at 7 mg/cm².
- The dosimetry and energy measurement specifications shall take precedence over irradiation geometry specifications.

4. A sealed ^{204}Tl beta-particle source meeting the following specifications:

   - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV.
   - The in-phantom dose rate at 20 mg/cm² divided by the in-phantom dose rate at 7 mg/cm² shall be 0.80 ± 0.05.
   - The dosimetry and energy measurement specifications shall take precedence over the irradiation geometry specifications.

5. A natural or depleted uranium slab meeting the following specifications:

   - The source protective covering shall be in the range between 3 mg/cm² and 7 mg/cm² inclusive.
   - The dose rate at 100 mg/cm² divided by the dose rate at 7 mg/cm² shall be 0.58 ± 0.04.
   - The in-phantom dose rate at 1000 mg/cm² shall be less than 3% of the dose rate at 7 mg/cm².
   - The measurement specification shall take precedence over the geometry specification.
   - The dimensions of the source must exceed the dimensions of the irradiated dosimeters.

6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[11]

2.3 Radiation Field Calibrations

Procedures used for calibrating radiation fields shall reference them to source fields standardized by NBS and shall be consistent with accepted national standards and practices. Reference class instruments, as defined in NBS Special Publication 603,[12] or sealed radioactive sources shall be used. (A list of calibration services offered by NBS is included in NBS Special Publication 250.[6]) The testing laboratory shall participate in a Measurement Quality Assurance Program with NBS.

The list of reference sources is given in Table 1. The rationale for selecting the reference calibration sources is discussed in Section A.1 of Appendix A. Requirements for beta calibration spectra are discussed in Section A.2 of Appendix A.

2.3.1 Photon Fields. Photon radiation fields shall be calibrated in terms of exposure in free air. Reference class ionization chambers calibrated by NBS for the particular techniques specified in Table 1 shall be used for the NBS techniques and the ^{137}Cs source. Other photon sources shall be calibrated with a reference class ionization chamber with a measured slowly varying energy dependence which has been calibrated by NBS or intercompared with NBS calibrated chambers in the appropriate energy range.

The dose equivalent assigned to exposed dosimeters shall be calculated using the exposure-to-dose-equivalent conversion factors (C_x) listed in Table 2. (The rationale used for choosing this particular set of C_x factors is given in Appendix A, Section A.3.) Absorbed dose and dose equivalent for radioactive source irradiations shall be calculated:

$$H_s = QC_{x,s}\dot{X}_{air}t; \quad H_d = QC_{x,d}\dot{X}_{air}t; \qquad D_d = C_{x,d}\dot{X}_{air}t \tag{4}$$

where $\dot{X}_{air}$ is the exposure rate in air calibrated using the above procedure, s refers to shallow, d refers to deep, t is the irradiation time and Q is the quality factor (1 Sv/Gy). The shallow dose equivalent rate for ^{137}Cs exposures shall be measured for each source and the irradiation geometry shall be adjusted to achieve a $C_{x,s}$ value of 1.03 ± 0.05 rem/R. The suggested method is with an extrapolation chamber embedded in a methylmethacrylate phantom.

For x-ray exposures referenced to an unsealed monitor ionization chamber,

$$H_s = QC_{x,s}TMC_{TP}; \quad H_d = QC_{x,d}TMC_{TP}; \qquad D_d = C_{x,d}TMC_{TP} \tag{5}$$

Table 2. Exposure-to-dose-equivalent conversion factors for photons[a]

NBS Filtered X-ray Techniques	C_x Conversion Factors, rem/R[b]	
Technique	Shallow (0.007 cm)	Deep (1.0 cm)
M30	1.08	0.45
S60	1.15	1.07
M150	1.41	1.47
H150	1.41	1.41
K-Fluorescence X-ray Techniques		
Energy, keV		
16	1.08	0.38
24	1.07	0.74
34	1.07	0.99
43	1.28	1.30
58	1.47	1.54
78	1.61	1.72
100	1.59	1.74
^{137}Cs		
662	—[c]	1.03

a. Data taken from Yoder et al.[13]

b. The SI unit conversions are 1 rem = 10^{-2} Sv and 1 R = 2.58×10^{-4} C/kg.

c. This value is dependent on source geometry and shall be measured for each source. The irradiation geometry must be adjusted to achieve a value of 1.03 ± 0.05 rem/R.

where T is the exposure-per-charge calibration factor for the monitor chamber at the standard temperature and pressure; M is the reading of the monitor chamber in units of charge; and C_{TP} is the temperature and pressure correction factor for the monitor chamber.

2.3.2 Beta-Particle Fields. Beta-particle fields shall be calibrated in terms of absorbed dose at a tissue depth of 7 mg/cm² using a thin-window, tissue-equivalent extrapolation chamber with the appropriate thickness of tissue-equivalent material in front of the window. The extrapolation chamber shall be calibrated using a beta-particle source with a calibration referenced to standards maintained by NBS. A tissue-equivalent extrapolation chamber typically contains a shell, a collecting electrode, and a front window of tissue-equivalent plastic. If air is used in the volume, an appropriate correction factor (stopping power ratio) shall be required.

Calibration depths used for beta irradiations can range from a few tenths of milligrams per square centimeter to 7 mg/cm². If a source has been calibrated at depths other than 7 mg/cm², measurement of a transmission factor shall be performed. The transmission factor shall be measured with a thin-window ionization chamber or extrapolation chamber. The chamber shall be positioned with its effective center at the calibrated point. Measurements shall then be performed at the depth of calibration and at a depth of 7 mg/cm². If material must be added to reach the required measurement depth, it shall be placed in contact with the chamber window. The total material thickness should be within ±0.5 mg/cm² of the nominal measurement depth or measurement data collected with greater

and lesser thicknesses shall be used to obtain the correct value by interpolation. The transmission factor shall be calculated as follows:

$$C_{trans} = \frac{\dot{X}\,(7\ mg/cm^2)}{\dot{X}\,(d)} \qquad (6)$$

where $\dot{X}$ is the relative chamber signal, corrected for temperature and pressure, and d is the original calibration depth.

The dose equivalent assigned to exposed dosimeters shall be calculated using

$$H_s = \dot{D}_t(d) \cdot t \cdot Q \cdot C_{trans} \qquad (7)$$

where $\dot{D}_t$, is the absorbed dose rate at the calibration depth d, t is the time, and Q is the quality factor (1 Sv/Gy).

2.3.3 Neutron Fields. The ^{252}Cf sources shall be calibrated in terms of neutron emission rate by NBS or another qualified laboratory using equipment and techniques referenced to NBS-maintained standards. Procedures for calculating the dose equivalent for exposed dosimeters shall follow NBS Special Publication 633.[5] In this publication the free-field dose equivalent (mrem) for unmoderated exposures is defined by:

$$H_d = \frac{N \cdot C_U \cdot t \cdot 3600}{4\pi r^2} \qquad (8)$$

where N is the neutron emission rate (n/sec), C_U is the dose-equivalent conversion factor for unmoderated ^{252}Cf (3.33×10^{-5} mrem-cm^2/n), t is the time (h), 3600 is the number of seconds in an hour, and r is the calibration distance (from the source center to the front face of the phantom, cm). For the moderated source,

$$H_d = \frac{N \cdot C_M \cdot t \cdot 3600 \cdot 0.885}{4\pi r^2} \qquad (9)$$

where C_M is the dose-equivalent conversion factor for moderated ^{252}Cf (9.08×10^{-6} mrem-cm^2/n), and the 0.885 factor allows for the loss of the number of neutrons moderated below the cadmium cutoff.[14]

NOTE: Ing and Cross[15] quote slightly different values for C_M because they use a lower limit of 1 eV for their calculations. The effect of the neutrons between the cadmium cutoff and 1 eV account for differences in C_M and the neutron loss fraction (see explanation in Schwartz, Eisenhauer and Grundl[16]).

The applicant can obtain direct calibration factor(s) from the testing laboratory. Otherwise, the applicant should consider applying correction factors to the dosimeter readings for air scattering, room return, and source scattering. These techniques are described in NBS Special Publication 633.[5]

The photon component for each irradiation source geometry shall be measured. Unmoderated ^{252}Cf irradiations probably have a greater variation of photon component than the moderated irradiations because of greater relative differences in source filtration. Typical values are 7% of the neutron dose equivalent for unmoderated irradiations[17] and 18% for moderated irradiations.[18]

2.4 Irradiation Geometries and Uncertainties

The dosimeters shall be irradiated using a phantom backing, except for on-contact slab-source exposures. The phantom shall be methylmethacrylate slabs measuring 30 cm x 30 cm x 15 cm for photon calibrations, 30 cm x 30 cm x 5 cm (or greater) for beta-particle calibrations, and 40 cm x 40 cm x 15 cm for neutron calibrations. The dosimeters shall be attached to the surface of the phantom facing the source (front face). For collimated beams, the central beam axis is positioned perpendicular to and passing through the center of the front face of the phantom. For uncollimated beams, the center of the front face of the phantom is positioned perpendicular to a radial line from the source center. Dosimeters shall be mounted with the sensitive elements within the central 15-cm x 15-cm area of the phantom for photon and beta-particle irradiations and within the central 20-cm x 20-cm area for neutron irradiations. The point of calibration shall coincide with the center of the front face of the phantom. The irradiation geometries summarized in Table 3 shall be used.

For photon and beta-particle irradiations, the scatter from the surfaces of the irradiation room and from the source and phantom support hardware shall contribute only a small fraction to the uncertainty in the assigned dose equivalent. If several dosimeters are irradiated simultaneously, precautions shall be taken to keep the mutual interference much smaller than the uncertainty in the assigned dose equivalent.

Table 3. Dosimeter irradiation geometries

Source Type	Phantom Size, cm	Distance, cm[a]	Maximum Useful Area[b]
Photon Sources	30 x 30 x 15		15 cm x 15 cm
^{137}Cs		≥ 100	
NBS filtered x-rays		≥ 100	
Monoenergetic x-rays		≥ 50	
Beta Sources			
$^{90}Sr/^{90}Y$	30 x 30 x ≥ 5	≥ 30	15 cm x 15 cm
^{204}Tl	30 x 30 x ≥ 5	30-50	15 cm x 15 cm
Slab Uranium	—	On contact	—
Neutron Sources	40 x 40 x 15	≥ 50	20 cm x 20 cm

a. Distance from the source center to the front face of the phantom.

b. Position dosimeters so that the sensitive elements fall within the useful area, centered on the front face of the phantom.

The uncertainty in the assigned dose equivalent shall not exceed ± 5%, excluding uncertainties in the dose equivalent conversion factors and the photon component of the neutron irradiations. Dose-rate uniformity measurements shall be performed to determine the useful exposure area. Included in the 5% limit are uncertainties due to source standardization, the uncertainty due to dosimeter position, and the uncertainty due to scattered radiation not stemming from the phantom. The systematic and random uncertainties shall be summed quadratically and separately. The ± 5% limit shall be imposed on the total linear sum of the systematic and random uncertainties. (Refer to Chapter 23 of NBS Handbook 91[19] for guidance on quoting uncertainties.)

NOTE: To achieve a total uncertainty not in excess of ± 5%, it may be necessary to measure and use position-specific correction factors. This can reduce the contribution to the total uncertainty due to dose-rate nonuniformity to an acceptable level.

2.5 Irradiation Level Selection

In each category, the irradiation levels shall be chosen at random using the logarithms of the dose equivalents or absorbed doses. Random selection of the logarithms of the irradiation levels rather than the levels themselves increases the probability of selecting values near the lower limit of the range. Values for the 1-cm depth shall be used except for the beta-particle category or mixtures using beta sources, for which the shallow depth shall be used. In addition, for the categories dealing with mixed radiation fields, the component ratios shall be selected at random. In these categories, the assigned dose equivalent of the larger component shall not be greater than three times that of the smaller component. The test range for the mixture categories specified in Table 4 applies to the summed dose equivalent.

The method for selecting irradiation levels within any one test category and test irradiation range shall be to select random numbers, ρ, between 0 and 1 and to represent the logarithm of the dose equivalent, H, as

$$\log H = \log(H)_\ell + \rho[\log(H)_u - \log(H)_\ell], \qquad (10)$$

where $(H)_\ell$ and $(H)_u$ are the lower and upper limits, respectively, of the range of test irradiation levels in question. The logarithms of absorbed doses shall also be selected using the same method.

Table 4. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 4. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]	One energy from each category	0.05-5 rem	Shallow,
III & V		0.2-5 rem	Deep
IV & V[a]		0.2-5 rem	
III & VI[h]		0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 1.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 11).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

3. PERFORMANCE STANDARDS

3.1 Performance Criteria

Performance in a given category or subcategory (see Table 4) shall be considered adequate if, for the shallow and/or deep dose equivalents (or the deep absorbed dose)

$$|B| + S \cdot |E| \leq L \qquad (11)$$

where B and S designate, respectively, the bias and standard deviation of the performance quotient for the particular category or subcategory, E is the estimation of the fractional uncertainty in the delivered dose or dose equivalent rate, and L is the tolerance level. The values of L shall be the following:

$$L = 0.30 \text{ for Categories I through VI}$$
$$L = 0.40 \text{ for Category VII.} \qquad (12)$$

A modified performance criterion in lieu of Equation (11) shall be acceptable for the ^{204}Tl tests. The ^{204}Tl source shall not be used for mixtures (Category VII). The modified criterion is:

$$|B| \cdot |E| \leq 0.40 \ (^{204}Tl \text{ only}) \qquad (13)$$

The performance criteria in Equations (11), (12) and (13) shall be used until two years after the effective date of the DOE Order.[20] At that time, Equation (12) shall be changed to: "L = 0.30 for all categories" and Equation (13) shall be deleted. The performance criteria for ^{204}Tl shall then be the same (including mixtures) as for the other test sources.

NOTE: The standard of performance is based on achievable standards consistent with the goals of health protection. The test criterion,

$$|B| + S \leq 0.30 \qquad (14)$$

can be interpreted as providing approximately 70% confidence that a dosimeter response would be within 30% of a conventionally true value. However, for workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence that the annual reported dose equivalent would be within 30% of a conventionally true value. The relationship of this criterion to the recommendations of the National Council on Radiation Protection and Measurements, the International Commission on Radiation Units and Measurements and the International Commission on Radiological Protection are contained in Appendix B.

The estimation of uncertainty (E) was included in the test algorithm to decrease the probability of an inadequate test result being assigned to an adequate dosimetry system. The test applicant receives the benefit of the uncertainty in the delivered dose or dose equivalent.

The ability of a dosimetry system to meet the performance criteria is typically limited by the mixture categories, especially those mixed with the low energy photon category. The tolerance level for mixture categories was set to 0.40 from 0.30 for the first two-year testing period to allow for unexpected difficulties and provides time for adjustments to meet the more stringent criteria to be imposed later.

The test for the low-energy beta source (^{204}Tl) is not required to use Equation (11) for the initial two-year period because of the technological and practical limitations of current dosimeter designs. The ^{204}Tl test algorithm was chosen based on the low-energy beta performance reported by Roberson et al.[3]

The number of dosimeters submitted for a category may be doubled (from 15 to 30) if the fractional standard deviation for that category is greater than 0.15. Determining which categories qualify is the responsibility of the applicant, with concurrence by the testing laboratory (see Section 2.1.2). If the performance of a dosimetry system is found inadequate at the conclusion of a performance test and the estimated probability is greater than 5% that the inadequate result was due to statistical fluctuations in the testing procedure, it shall be so noted on the test results and the applicant should consider submitting 30 dosimeters to that category during the subsequent retest period.

NOTE: The statistical uncertainty of the test results increases with the standard deviation (see Appendix B). Table B.1 of Appendix B lists the (approximate) two standard deviation uncertainties of the test result as a function of the true dosimeter standard deviation and the number of dosimeters used. These values may be used to estimate the probability of an inadequate performance due to

the uncertainties in the test results. Doubling the number of test dosimeters will decrease the effects of the test uncertainties.

The performance test shall be split into three parts in a period not shorter than 3 months and not longer than 6 months (see Section 2.1.3).

NOTE: The standard deviation is composed of dosimeter variations present in a batch of dosimeters read sequentially and the long-term variability of the calibration-plus-readout process. A sampling of the long-term variability is accomplished by splitting the evaluation over a period of time.

3.2 Irradiation Categories

The evaluation of the personnel dosimetry system shall use the categories listed in Table 4. The applicants shall submit dosimeters for testing in the high-dose categories (I and II) corresponding to the similar protection categories (III and IV).

NOTE: The high-dose category corresponding to Category IIIB is Category I due to the difficulty of achieving high-dose levels with nearly monoenergetic sources.

The nearly monoenergetic low-energy photon sources (Category IIIB), the uranium slab source (Category VB), and the special beta point sources (Category VC) were included for application to specific occupational environments. These categories may be used in place of or in addition to Categories IIIA and VA, depending on the occupational environments included in the service. Dosimetry services for an occupational environment containing significant quantities of plutonium shall use Category IIIB. If the same service covers areas with general x-ray sources, Category IIIA shall also be used.

Dosimetry services covering occupational environments containing uranium sources and having an established beta calibration program using slab uranium may use Category VB in place of VA. If the dosimetry service also covers environments with general beta emitters, then testing in Category VA shall be performed.

Category VC shall be used by contractors requiring either a high-energy or low-energy beta source test only. The desired source shall be specified before initiation of the performance test. If both high- and low-energy sources are required, Category VA shall be used. If both low-energy photon categories (IIIA and IIIB) or if two of the beta categories (VA, VB, and/or VC) are required, the dosimetry system may use different algorithms corresponding to those used for the different occupational environments.

If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) and uses the same algorithms for both categories, then only 5 dosimeters shall be submitted for each corresponding mixture category involving those categories. The spectra for those mixture irradiations shall be selected at random from the combined category. If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) using different algorithms for each category, then 10 dosimeters shall be submitted for each mixture, 5 for each category. In such cases, the applicant shall submit results using both algorithms. The testing laboratory shall choose only the appropriate irradiation categories for the performance test for each algorithm.

NOTE: Category VC was included to accommodate special dosimetry environments. It is expected that the choice of Category VC will be accompanied by a justification. Field measurement data may be required.

The radiation source from Category IIIA and each mixture category involving IIIA shall be chosen for each of the three testing parts at random without replacement. The choice of sources from Category IIIB and each mixture category involving IIIB will alternate for each test part. For each of the Categories IIIA, IIIB, IV, VA, VB, and VC and the mixture categories not using neutrons, the category used for individual irradiated dosimeters shall not be identified to the applicant until after test results are reported to the applicants. In addition, the sources used for the low-energy photon irradiations and the Category VA beta particle irradiations shall not be divulged until the test results are reported.

An applicant participating in neutron tests shall specify which neutron source most appropriately represents the spectral composition of occupational neutron fields which the dosimetry program covers. If both sources are required to adequately represent these neutron fields, the performance testing shall include both sources. The applicant may identify in advance the dosimeters submitted for the neutron tests. When the dosimeters are

returned for evaluation, the participant shall be told which dosimeters were irradiated with neutrons and which source was used. The testing laboratory shall provide pretest calibration exposures for the neutron sources upon request. The testing laboratory shall also provide the ratio of readings from a 9-in.-diameter spherical rem meter and a 3-in.-diameter sphere covered with 10-mil-thick cadmium as a relative calibration for albedo dosimeters.[21]

NOTE: This standard directs the testing laboratory to provide the calibration factor for the neutron performance tests to the applicant. The bias should indicate the ability to calibrate the dosimetry system to an external source. The dosimeter response relative to the testing source(s) and the occupational environments must be documented (see Section 1.3).

3.3 Angular Dependence

For each dosimeter design submitted for testing and for each type of radiation in Categories III through VI for which performance is tested, a study of dosimeter performance when the incident radiation is nonperpendicular shall be carried out once. The study need not be a part of a test series or performed by the testing laboratory. At least two different radiation spectra shall be used in Category IIIA and IIIB; low and mid-range energies should be considered. Category VB is excluded from this requirement. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for Angular Dependence Study. Mount the dosimeters on the front face of the phantom specified for the performance tests. Give identical irradiations to at least two dosimeters of each kind. Vary the angle of incidence in two planes perpendicular to each other and to the plane of the dosimeter in the original test configuration. Vary the angle by rotating the phantom through the appropriate angle. To achieve rotations along the horizontal axis of the dosimeter, rotate the dosimeter 90° on the phantom and rotate the phantom along its vertical axis.

At least seven different angles of incidence from -85° to +85°, including 0° (perpendicular incidence), shall be used in each of the two planes. Values for the dose equivalent for each irradiation exposure should be approximately 500 mrem. For a given angle of incidence and type and energy of incident radiation, the results of the angular dependence study shall be expressed as the ratio of the applicant's dose equivalent interpretation to the actually administered dose equivalent obtained on the basis of perpendicular incidence.

3.4 Lower Limit of Detectability

For each dosimeter design submitted for testing and for at least one source in Categories III through VI for which performance is tested, a study to determine the lower limit of detectability shall be conducted once and reported to the testing laboratory. The study need not be part of a test series or performed by the testing laboratory. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for the Lower Limit of Detectability Study. At least 10 dosimeters for irradiation per category, plus 10 dosimeters for background evaluation, for each dosimeter design, shall be selected from the routine-processed pool of dosimeters for this study. The dosimeters shall be placed in an unshielded environment for a time sufficient to obtain an unirradiated background signal typical for routine processed dosimeters. At least ten dosimeters shall be irradiated for each category to a dose significantly greater (e.g., 500 mrem) than the estimated lower limit of detectability. Both the irradiated and unirradiated dosimeters shall be processed and evaluated. The following quantities shall be calculated:

$$H_o = \frac{1}{n} \sum_{i=1}^{n} X_{io} \tag{15}$$

$$S_o = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{io} - H_o)^2 \right]^{1/2} \tag{16}$$

$$H_1 = \frac{1}{n} \sum_{i=1}^{n} X_{i1} \tag{17}$$

$$S_1 = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{i1} - H_1)^2 \right]^{1/2} \tag{18}$$

where X_{io} = unirradiated dosimeter values and X_i = irradiated dosimeter values. The values H_o and H_1 are the mean evaluated dose equivalent values

for the unirradiated and irradiated dosimeters, respectively, and S_o and S_I are the associated standard deviations. The dosimeter readings shall be processed through the dose algorithms without truncation or distortion (i.e., do not zero any readings). If a background is subtracted, negative values shall be retained for the calculation of S_o. The algorithms for the calculation of shallow and/or deep dose equivalent shall be used to calculate H_o and H_I, depending on the category test specifications. The lower limit of detection, L_D shall be calculated as follows:

$$L_D = 2\,[t_p S_o + (t_p S_I/H_I)^2\, H_o'] \,/\, [1 - (t_p S_I/H_I)^2] \qquad (19)$$

where t_p is the t distribution for n-[legrees of freedom and a p value of 0.95 (see NBS Handbook 91[19]) and H_o' is the average of the unirradiated dosimeter values without subtracting a background signal.

Alternate Method. If the performance testing was completed within six months of this study, then the values of B and S may be used to calculate [1.75 x S/(1 + B)] which may be used in place of $t_p S_I/H_I$ in Equation (19) for each category. Only a set of unirradiated dosimeters would be required to determine L_D.

NOTE: Equation (19) is based on the desire to minimize both false negative and false positive results. All values below the detection threshold should be set to zero. For example, $t_p S_o$ for p = 0.95 is an estimate of the detection threshold allowing 5% false positive values. For the lower limit of detection false negative values are also minimized. For p = 0.95, the probability of no more than 5% false positive and false negative values provides a lower limit of detection of:

$$L_D = t_{p,o} S_o + t_{p,D} S_D \qquad (20)$$

where S_D is the standard deviation at the lower limit of detectability and $t_{p,o}$ and $t_{p,D}$ depend on the number of dosimeters used to estimate S_o and S_D, respectively.

Equation (20) is an estimate of the equation

$$L_D = K_p \sigma_o + K_p \sigma_D \qquad (21)$$

where σ_o and σ_D are the true standard deviations and K_p is the abscissa of the standard normal distribution below which the total relative area under the curve is P. The σ_D value is composed of the fluctuation of the background (σ_o) and the fluctuation inherent in the readout process. If σ_I/H_I is the relative standard deviation at high doses, then

$$\sigma_D^2 \simeq \sigma_o^2 + \left(\frac{\sigma_I}{H_I}\right)^2 (L_D^2 + 2\, L_D H_o) \qquad (22)$$

and solving for L_D,

$$L_D = 2\left[K_p\sigma_o + \left(K_p \frac{\sigma_I}{H_I}\right)^2 H_o\right] \Big/ \left[1 - \left(K_p \frac{\sigma_I}{H_I}\right)^2\right] \qquad (23)$$

Using t_p for K_p and S for σ, Equation (19) is obtained. If $t_{p,o}$ is not equal to $t_{p,D}$, the formula for L_D is not exact, but should be a close approximation. Additional information can be found in an article by Currie.[22]

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APPENDIX A

CHOICE OF REFERENCE CALIBRATION SOURCES

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Comparisons of occupational exposures reported for various DOE sites are made more difficult by the absence of standard calibration techniques and the use of many dosimeter designs. The establishment of reference calibration techniques will help quantify the effects of differing dosimeter designs and differing occupational environments. The choice of reference sources was based on an intercomparison of dosimeter system performances for DOE laboratories[A-1] and the American National Standards Institute's *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11.[A-2] Eleven DOE laboratories participated in the intercomparison to better define present differences and help develop improved techniques.

The intercomparison of dosimetry system performances was also used to evaluate ANSI N13.11 for use by DOE facilities. It was found that: 1) the number of test categories was incomplete; 2) the performance criteria specified did not achieve the goal of the tests as well as other algorithms; 3) the beta-particle category was not sufficiently specified; and 4) the choice of the photon conversion factors was arbitrary. The choice of reference sources was made to be as consistent with ANSI N13.11 as was practical.

A.1 Calibration Categories

The filtered x-ray beams chosen for Table 1 (main text) are National Bureau of Standards (NBS) techniques.[A-3] The M30 (20-keV) and S60 (36-keV) techniques represent the photon energy region of maximum response for most dosimetry systems. They represent a conservative worst-case test for low-energy photons. The M150 (70-keV) and H150 (120-keV) techniques are included to extend the test energies above those influenced by the photoelectric effect. The response of dosimetry systems is similar to that of tissue from approximately 200 keV to 2 MeV because of the dominance of the Compton interaction. Tests at these energies are represented by the high-energy photon category. Nearly monoenergetic x-ray sources at 15 to 20 keV and 55 to 65 keV and the ^{241}Am (59-keV) source were included specifically for facilities using plutonium.

Adequate performance for the ^{90}Sr/^{90}Y beta source does not imply adequate performance for all beta-particle energies. The ^{90}Sr/^{90}Y beta particles are sufficiently energetic to penetrate the popular, thick (235-mg/cm^2) LiF thermoluminescent (TL) dosimeter chip. This penetration results in a response for ^{90}Sr/^{90}Y similar to the response for ^{137}Cs for some dosimeters that are nearly insensitive to low-energy beta particles. Inclusion of the ^{204}Tl source (0.76-MeV maximum energy) requires that some attention be given to the lower energies. Reference sources with energies lower than that provided by the ^{204}Tl source may be included following improvement in dosimeter technology. The ^{204}Tl source was chosen because of its ease of use and single beta spectrum.

A uranium slab source was added for occupational environments containing uranium and because of the popularity of this source type for dosimeter calibrations. Because source construction details may change dose rates slightly, extrapolation chamber measurements were specified for the calibration at 7 mg/cm^2 and the depth-dose determination at 100 mg/cm^2. Source construction and geometry effects are constrained by the depth-dose specification, which was calculated using measurements reported in the literature,[A-4,A-5] and which were subsequently checked by direct measurement. These measurements indicate that the depth-dose specification can be met for slab sources with protective coatings in the range of 3 mg/cm^2 to 7 mg/cm^2.

The use of dosimeters far from a uranium source may result in inaccurate readings compared to the uranium slab calibration. The slab geometry provides a less-penetrating depth-dose distribution than the point source geometry. Proper use of the source calibration can be determined using measurements performed in the occupational environments.

The response ratio of DOE albedo neutron dosimeters for moderated and unmoderated ^{252}Cf irradiations varies from approximately 6 to 20.[A-1] Because the variations are so large, both sources were chosen for use as reference sources. For the performance evaluation, the type of neutron source is provided before the dose equivalents are reported. The moderated ^{252}Cf source was chosen to be consistent with ANSI N13.11. Unmoderated ^{252}Cf irradiations can easily be performed as a variation of the moderated ^{252}Cf irradiations. More

stringent neutron tests may be included following improvements in neutron dosimeter technology.

A.2 Additional Specifications for Beta Calibrations

Beta calibrations are affected by source geometry, source filtration, dosimeter irradiation technique, beam calibration technique, and environmental conditions. The ANSI N13.11 standard specifies inherent source filtration, phantom size, and source-to-phantom distance for $^{90}Sr/^{90}Y$ irradiations but does not adequately address other parameters. Considerable variability in dosimeter response per unit delivered dose has been observed among $^{90}Sr/^{90}Y$ sources set up to ANSI N13.11 specifications. Additional constraints are necessary to standardize beta calibration techniques.

This standard specifies that beta irradiations be standardized according to depth-dose characteristics and source energy criteria in the international standard ISO 6980.[A-6] The specifications for $^{90}Sr/^{90}Y$ irradiation are related to the mean energy of the source (100-mg/cm^2 specification) and Bremsstrahlung production (1000-mg/cm^2 specification). For ^{204}Tl irradiations, only a specification related to mean energy is given (20-mg/cm^2 specification). The depth-dose specifications are intended to take precedence over the source filtration specifications. The intention is to allow the use of source geometries specified in ISO 6980 while maintaining irradiation consistency between laboratories. The depth-dose specification for the slab uranium exposures was added to help control variations in source manufacture and geometry.

A.3 Factors for Converting Exposure to Dose Equivalent for Photons

The exposure-to-dose-equivalent conversion factors for low-energy photons (C_x factors) listed in ANSI N13.11 were derived by Dimbylow and Francis for the four-element ICRU sphere using Monte Carlo calculations.[A-7] For the dosimeter performance tests, the dosimeters are mounted on a slab phantom of methylmethacrylate. Personnel dosimeters are designed to monitor for dose to the tissue of the body on which they are mounted. However, the performance tests require that they monitor for dose to the ICRU sphere while mounted on a slab phantom. This results in the miscalibration of even ideal personnel dosimeters.

The choice of the phantom shape for the specification of C_x factors is not arbitrary, as has been argued.[A-8] The size and shape of the phantom is important for monitoring low-energy photons because radiation is scattered back to the surface. Backscatter can contribute an additional 40% to 50% to the dose at the surface for photon energies between 60 and 100 keV.[A-9] The dosimeter ideally would be able to properly record the level of backscattered radiation and, thus, approximately compensate for fluctuations dependent on the size of the wearer.

The contribution due to backscattered radiation is different for the slab and spherical phantoms. Nelson and Chilton used Monte Carlo calculations to derive the C_x factors for the slab geometry with the ICRU four-element composition.[A-10] Their results agreed closely with the calculations of Dimbylow and Francis (spherical geometry) below 50 keV, but were 20% higher between 80 and 100 keV. This difference accounts for the major discrepancy between the spherical-geometry C_x factors specified in ANSI N13.11 and the available measurements using slab geometry by Yoder et al.[A-11] Nelson and Chilton also performed calculations for the tissue-equivalent plastic used by Yoder et al. for direct measurements of C_x factors using the slab geometry. The significant difference between the calculations for the Yoder plastic and the measurements was at energies below 20 keV. Nelson and Chilton attributed this difference to a higher-energy contamination in the k-fluorescence spectra used by Yoder et al.

Because of the use of slab phantoms for the reference calibrations, conversion factors for the slab geometry are used. The best available data are by Yoder et al. and are listed in Table 2 of the main text.

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APPENDIX B

DERIVATION OF PERFORMANCE CRITERIA

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The specifications of performance criteria were based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[B-1] A direct relationship between the performance criterion and the response of each dosimeter was maintained by expressing the criterion as a confidence limit rather than a calibration bias limit only. The confidence limit concept was also used in ANSI N13.11-1983.[B-2] The goal was to develop a statistic for which there would be a specified confidence that the dosimeter readings would be within a specified interval.

For a large number of dosimeter readings obeying a normal distribution, there is a confidence level, β, for which the readings are within the interval

$$M - Z_\alpha \sigma \text{ to } M + Z_\alpha \sigma \qquad \text{(B-1)}$$

where M is the mean; σ is the (one sigma) standard deviation of the total population; and Z_α is the standard normal variable for $\alpha = 1/2\ (\beta + 1)$. The entire interval may be required to be within a specified tolerance of a conventionally true value (CTV) by stating:

$$M + Z_\alpha \sigma \leq CTV\,(1 + L)$$

and

$$M - Z_\alpha \sigma \geq CTV\,(1 - L)$$

or

$$\frac{|M - CTV|}{CTV} + \frac{Z_\alpha \sigma}{CTV} \leq L \qquad \text{(B-2)}$$

where L is the fractional tolerance interval.

For a performance test using n dosimeters, the bias (B) and the standard deviation (S) of the performance indices are estimates of (M - CTV)/CTV and σ/CTV. Then the test statistic becomes

$$|B_n| + t_{\alpha,\nu} S_{n,\nu} \leq L \qquad \text{(B-3)}$$

where $\nu = n-1$ represents the number of degrees of freedom and the 't' statistic is used as an approximation of the standard normal variable due to the finite number of dosimeters used for the test.

The reasonably achievable test statistic chosen for the performance criterion was

$$|B| + S \leq 0.30 \qquad \text{(B-4)}$$

This statistic can be interpreted in several ways. If $t_{\alpha,\nu} = 1$ for n = 15 dosimeters, then there would be approximately 70% confidence ($\beta = 0.66$, $\alpha = 0.83$ for n = 15) that a dosimeter response would be within 30% of a conventionally true value. However, if a worker used four dosimeters per year and received approximately equal doses on each, then there would approximately 95% confidence ($\beta = 0.93$, $\alpha = 0.97$ for n = 15) that the annual reported dose equivalent would be within 30% of a conventionally true value.

Variations of the test statistic derivation are possible. Higher levels of statistical confidence that a test sample is representative of the true population can be obtained using tolerance statistics.[B-3] An interval can be constructed to cover at least a specified percent of all dosimeter readings in the total population with a desired probability. For example, for a 95% probability that 95% of the averages of four dosimeter readings are within tolerance (assuming uniform occupational exposures and a quarterly exchange rate), the test statistic becomes:

$$|B| + 1.45\,S \leq 0.30 \qquad \text{(B-5)}$$

for 15 sample readings. However, there is also the probability that a system that meets the 30% criteria exceeds the test statistic. For 95% probability that systems meeting requirements also meet the test statistic, the tolerance value (0.30) would have to be increased. Both approaches converge to the adopted test statistic as the number of sample dosimeters approaches infinity.

The relationship of the adopted test statistic (Equation B-4) to recommendations of the NCRP, ICRU and ICRP are given below.

Recommendations to NCRP 57[B-4]

The NCRP recommends several values of precision and accuracy depending on the circumstance. The recommended precision is ± 10% which allows comparison of reported values between individuals and over long periods of time. For reported values near the maximum permissible dose (MPD), an accuracy of ± 30% is recommended. For reported values less than 1/4 of the MPD, an accuracy of a factor of 2 is acceptable. At higher doses encountered during emergency procedures or accidents, an accuracy of better than ± 20% is recommended.

The precision of the reported values approximately corresponds to the 'S' value. While the test statistic does not require an S of 0.10 or less, there is an implied constraint on S of about 0.12 to 0.15. Larger values of S do not allow sufficient latitude for a minimal uncertainty in the bias, especially for multipurpose dosimeters which require some latitude in the bias to cover response variation as a function of radiation type and energy. The spirit of the recommendation for precision is accommodated.

The recommended accuracy near the MPD of 30% is implied to be used annually, since the MPD is applied annually. If a facility uses quarterly dosimeter exchanges, dosimeters receiving approximately equal doses per quarter would meet the 30% recommendations with approximately 95% confidence. The reported dose equivalent for a worker receiving all of the annual dose on one dosimeter would have an approximately 70% confidence of meeting the recommendation.

A test statistic variable in the magnitude of the delivered dose was contained in the early drafts of ANSI N13.11. The University of Michigan test concluded, and the DOE study concurred, that the split in the test statistic was unnecessary at current state of the art and was detrimental to the conduct of the test. Principally, a significantly larger number of dosimeters would be required to perform a variable-criteria test compared to a single-criteria test to achieve the same level of confidence in the results. Therefore, the allowance for a greater inaccuracy at lower doses was not included in the test criteria.

The test statistic does not meet the ± 20% recommendation on the accuracy at high doses. High doses are typically received by only one dosimeter, thus there would be 70% confidence that the reported dose is within 30%.

Recommendations in ICRU 20[B-5]

The ICRU recommends that an accuracy of ± 30% be achieved when the maximum dose equivalent is comparable to the maximum permissible dose. At a level of 0.1 of the maximum permissible dose, a maximum allowable uncertainty of a factor of three is suggested. At doses much greater than the maximum permissible dose, the ICRU recommends that the accuracy be increased, possibly with special effort applied postexposure.

The accuracy recommended by the ICRU is similar to that quoted by the NCRP at radiation protection levels. At high doses, the ICRU encourages the use of special efforts to improve the dose estimate for each individual worker. The adopted test criteria is in approximate agreement with these recommendations. However, there is no test requirement to demonstrate the ability to improve the accuracy after the exposure.

Recommendations in ICRP 35[B-6]

The ICRP recommends that the uncertainty in the annual reported dose equivalent be reduced as far as is reasonably achievable. It further recommends minimum levels of accuracy of a factor of 1.5 at the 95% confidence limit when the dose equivalent is on the same order as the annual maximum permissible dose, or within a factor of two at the 95% confidence level when the annual reported dose is less than 1 rem. Explicitly stated is that these accuracy limits include variations in dosimeter sensitivity, with incident energy and direction of incidence, and in dosimeter construction, readout, and calibration.

The first recommendation is met: the criteria was designed to be as low as is reasonably achievable. The recommended minimum levels of accuracy near the maximum permissible dose imply a test statistic of

$$|B| + 2S \leq 0.50 \text{ for B positive}$$

and (B-6)

$$|B| + 2S \leq 0.33 \text{ for B negative.}$$

The asymmetric criterion is due to the specification of a factor rather than a percent of the conventionally true value. This statistic implies an upper limit of S of 0.25, which is approximately achieved by

the adopted statistic (S_{max} = 0.30). The adopted criteria approximately corresponds to recommendations of the ICRP for S values near 0.20. However, the allowed inaccuracy of the bias for small S values is (nearly) as great as 50%. This allows too much inaccuracy in the calibration methods and dosimeter design, and is above the currently achievable level. Note that this approach does not require the use of quarterly dosimeter exchanges with the accompanying assumption of approximately equal doses received each quarter.

A source of inaccuracy included by the ICRP, but not included by the adopted test criteria is that due to direction of radiation incidence. The collection of angular response data is required by the DOE standard with no criteria on the performance. The application of the adopted test statistic may be alternatively viewed as allowing a confidence interval up to 0.2 for the inaccuracy in the angular response. The recommendations of the ICRP can be taken into account during the development and subsequent review of a test criteria for angular response.

The recommendations at the lower dose equivalent levels were not used for the same reason as was stated above for the NCRP recommendations.

Summary of Relationship to NCRP/ICRU/ICRP Recommendations[B-4 through B-6]

The adopted performance criteria were chosen to be as low as was reasonably achievable. The criterion is consistent with the recommendations of the NCRP,[B-4] ICRU,[B-5] and ICRP[B-6] with the following caveats:

- To meet the NCRP and ICRU recommendations of 30% for the accuracy, and do it with 95% confidence, at least four dosimeters receiving equal doses must be used. This may be approximately correct for the majority of workers, but is not adequate for all.
- The recommendations by the ICRP are approximately met for each dosimeter, and thus for each worker, except that the uncertainty due to angular response is neglected in the test criteria. The adopted test criteria are approximately equivalent to reserving up to 20% for additional (positive) bias due to angular response variations.
- The NCRP recommended accuracy in the high dose region is greater than is specified by the test criteria (20% NCRP versus 30% test criteria). The ICRU and ICRP favor special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions (e.g., position of dosimeter relative to the source distribution and body of wearer) are neglected in the test criteria.

Performance Test Uncertainty

The implementation of the test statistic as given in Equation (B.4) may require large numbers of dosimeters to measure |B| and S with sufficient precision. Assuming that the dosimeter readings are normally distributed about a single mean, for 95% of the readings the magnitude of the bias is bounded by:

$$|B| \le \frac{|M - CTV|}{CTV} + \frac{Z_{0.975}}{\sqrt{n}} \frac{\sigma}{CTV} \qquad \text{(B-7)}$$

For 95% of the samples the standard deviation is approximately bounded by:

$$S \le \left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} \cdot \frac{\sigma}{CTV} \qquad \text{(B-8)}$$

using a χ^2 distribution with (n - 1) degrees of freedom. Because the uncertainties in B and S are independent for normally distributed data, a close approximation to the interval containing 95% of the parent population is:

$$[|B| + S]_{max} = \frac{|M - CTV|}{CTV} + \frac{\sigma}{CTV} + \left\{ \left(\frac{Z_{0.975}}{n} \right)^2 + \left[\left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} - 1 \right]^2 \right\}^{1/2} \frac{\sigma}{CTV} \qquad \text{(B-9)}$$

The term in brackets on the right-hand side is the amount by which a system that meets the goals for accuracy could fail the test statistic due to a statistical fluctuation of a measurement. This term can be

Table B-1. Statistical uncertainty term

σ/CTV	Number of Dosimeters	Approximate Value of Uncertainty Term
0.08	15	0.05
0.17	15	0.10
	30	0.17
	60	0.05
0.24	15	0.14
	30	0.10
	60	0.07
	120	0.05

reduced by increasing the number of dosimeters per test. Table B.1 lists the approximate values of the statistical terms as a function of σ and the number of dosimeters used per test. For an uncertainty of 5%, 15, 60, and 120 dosimeters are required for standard deviations of 0.08, 0.17, and 0.24, respectively. Similar requirements for the number of sample dosimeters can be derived using tolerance statistics for 95% probability that 70% of a parent population with $|B| + S = 0.25$ is within tolerance.

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U.S. Department of Energy
Idaho Operations Office
Idaho Falls, ID

T. F. Gesell, Chief
Dosimetry Branch
Radiological and Environmental
Sciences Laboratory
U.S. Department of Energy
Idaho Falls, ID (50)

R. D. Carlson
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Radiological and Environmental
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National Laboratory,
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C. L. Graham, Lawrence Livermore
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Livermore, CA

R. M. Hall, E. I. DuPont
deNemours & Co.,
Savannah River Plant, Aiken, SC

R. Lawrence, West Valley
Nuclear Services
P.O. Box 191
Rock Springs, Rd., West Valley, NY

W. Nees
United Nuclear Corp.
P.O. Box 14000
Grand Junction, CO

J. J. Volpe
Westinghouse Electric Corporation
P.O. Box 2068
Idaho Falls, ID

C. D. Sorensen
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID

C. S. Abrams
Argonne National Laboratory
Idaho Site
P.O. Box 2528
Idaho Falls, ID

NRC Form 374
(3-83)

U.S. NUCLEAR REGULATORY COMMISSION

Amendment No. 22

MATERIALS LICENSE

FILE COPY

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law [illegible]), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Environmental Protection Agency Office of Research and Development National Exposure Research Laboratory 2. Characterization Research Division P.O. Box 93478 Las Vegas, NV 89193-3478	In accordance with letter dated November 9, 1995, 3. License number 27-05861-02 is amended in its entirety to read as follows:
	4. Expiration date February 28, 1994
	5. Docket or Reference No. 030-06981

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Hydrogen 3	A. Any	A. 5 millicuries
B. Any byproduct material with Atomic Nos. 3-83, and with half-lives less than or equal to 120 days	B. Any	B. Not to exceed 5 millicuries per radionuclide
C. Any byproduct material with Atomic Nos. 3-83 with half-lives greater than 120 days	C. Any	C. Not to exceed 1 millicurie per radionuclide and 25 millicuries total
D. Any byproduct material with Atomic Nos. 3-83	D. Sealed and/or plated sources	D. Not to exceed 5 millicuries per source and 100 millicuries total
E. Carbon 14	E. Any	E. 10 millicuries
F. Strontium 90	F. Any	F. 200 microcuries
G. Iodine 129	G. Any	G. 50 microcuries
H. Any byproduct, source or special nuclear material with Atomic Nos. 84-96	H. Any	H. Not to exceed 100 microcuries per radionuclide and 10 millicuries total

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MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number
27-05861-02

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Amendment No. 22

(continued)

I.	Any byproduct, source or special nuclear material with Atomic Nos. 84-96	I. Sealed and/or plated sources	I. Not to exceed 100 microcuries per source and 10 millicuries total
J.	Polonium 210	J. Any	J. 650 microcuries
K.	Uranium 233	K. Any	K. 10 microcuries
L.	Uranium 235	L. Any	L. 10 microcuries
M.	Plutonium 236	M. Any	M. 10 microcuries
N.	Plutonium 238	N. Any	N. 60 microcuries
O.	Plutonium 239	O. Any	O. 30 microcuries
P.	Plutonium 240	P. Any	P. 10 microcuries
Q.	Plutonium 241	Q. Any	Q. 10 microcuries
R.	Plutonium 242	R. Any	R. 10 microcuries
S.	Plutonium 244	S. Any	S. 5 microcuries
T.	Source material	T. Any	T. 15 pounds
U.	Nickel 63	U. Foils or plated sources in detector cells	U. 1 curie
V.	Cesium 137	V. Sealed source (U.S. Nuclear Model 375)	V. 1 millicurie
W.	Cobalt 60	W. Sealed source (U.S. Nuclear Model 375)	W. 5 millicuries
X.	Cesium 137	X. Sealed source (U.S. Nuclear Model 375)	X. 300 millicuries
Y.	Cesium 137	Y. Sealed source (New England Nuclear Model NER-572)	Y. 10 millicuries

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number
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030-06981

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(continued)

Z. Cesium 137	Z. J. L. Shepherd and Associates Series 6810 sealed sources (Reference Dwg. No. A-0348 dated July 24, 1976)	Z. Six sources consisting of the following activities: 10 curies, 1 curie, 100 millicuries, 10 millicuries (2 sources) and 1 millicurie
AA. Plutonium 239	AA. Sealed or plated sources	AA. Not to exceed 5 microcuries per source ard 100 microcuries total
BB. Hydrogen 3	BB. Titanium tritide foils in detector cells	BB. 5 curies
CC. Cesium 137	CC. Sealed source	CC. 100 millicuries
DD. Cesium 137	DD. Sealed source (Amersham Model CDC.711M Series)	DD. Not to exceed 3 curies per source and 6 curies total
EE. Cesium 137	EE. Sealed sources (NEN Model G316 B capsule and a J.L. Shepherd and Associates Type 6810 capsule, both reencapsulated in one source holder)	EE. 751 millicuries
FF. Americium 241	FF. Sealed sources (Amersham Model AMC.D2)	FF. Not to exceed 30 millicuries per source and 60 millicuries total
GG. Curium 244	GG. Sealed sources (Amersham Model CLCL or Isotope Products Model XFB series)	GG. Not to exceed 100 millicuries per source and 200 millicuries total

MATERIALS LICENSE
SUPPLEMENTARY SHEET

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9. Authorized Use

A. through T. To be used in laboratory and tracer studies and analysis; development and standardization of chemical procedures; instrument calibration; research and development as defined in 10 CFR Part 30.4; preparation and distribution of radioanalysis calibration standards and environmental-level laboratory intercomparison samples; and the local fabrication of subnanocurie electrodeposited sources for calibrations. Sealed sources may also be used for demonstration and training purposes in the laboratory and field.

U. To be used in gas chromatographs for sample analysis.

V. and W. To be used in J. L. Shepherd Model 28-5 devices for instrument calibration.

X. To be used in J. L. Shepherd Model 142-10 irradiator for instrument calibration.

Y. For storage only in a Mount Sopris Model 1000-C Portable Borehole Logger.

Z. For use in two concrete shielding wells for instrument and dosimetry calibration.

AA. For instrument calibration.

BB. To be used in gas chromatographs for sample analysis.

CC. For use in panoramic device for TLD and Pocket Dosimeter Calibration.

DD. To be used in a Williston Elin self shielding TLD irradiator to irradiate Panasonic TLDS.

EE. To be used in a J.L. Shepherd Model 89 Series Calibrator within a J.L. Shepherd Model 78 Series Self-Contained Calibration Facility for instrument calibration.

FF. and GG. To be used in Columbia Scientific Industries Corp. portable X-ray analyzer Model 886 for analysis of metal contaminants in soil and ground water.

CONDITIONS

10. Licensed material shall be used only at the licensee's facilities located at 944 East Harmon Avenue, Las Vegas, Nevada or the Department of Energy's Nevada Test Site, 65 miles northwest of Las Vegas, except:

    A. Sealed sources listed in Subitems B. through U. may be used for instrument calibration at the licensee's facilities at 4220 South Maryland Parkway, Building C; Las Vegas, Nevada.

    B. Sealed sources listed on this license which have individual activities less than those listed in Schedule B of 10 CFR 30.71 may be used for instrument calibration and demonstration at temporary job sites of the licensee anywhere in the United States.

    C. Sealed sources listed in Subitems Z. and CC. may be used only at the licensee's facilities at 944 East Harmon Avenue, Las Vegas, Nevada.

    D. Sealed sources listed in Subitem W. and EE. may be used for instrument calibration at temporary job sites of the licensee anywhere in the United States.

    E. Sealed sources listed in Subitems FF. and GG. may be used for soil and ground water analysis at temporary job sites of the licensee anywhere in the United States.

11. A. Licensed material shall only be used by, or under the supervision of, individuals designated by the Radiation Safety Committee, Stephen H. Pia, Chairperson.

    B. The Radiation Safety Officer for this license is Loyd D. Carroll.

12. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

    B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

    C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

(continued)

D. Each sealed source fabricated by the licensee shall be inspected and tested for construction defects, leakage, and contamination prior to any use or transfer as a sealed source.

E. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

(iv) they contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

F. The leak test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30(b)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. The report shall be filed within 5 days of the date the leak test result is known with the U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, ATTN: Director, Division of Radiation Safety and Safeguards. The report shall specify the source involved, the test results, and corrective action taken.

G. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically licensed by the Commission or an Agreement State to perform such services.

13. Sealed sources or detector cells containing licensed material shall not be opened or sources removed from source holders by the licensee.

14. The roof of the calibration facility (over Room 18 of the Monitoring Systems Laboratory, at 944 East Harmon Avenue, Las Vegas, Nevada) shall be fenced and posted "Caution Radiation Area."

15. In lieu of using the conventional radiation caution colors (magenta or purple on yellow background) as provided in 10 CFR 20.203(a)(1), the licensee is hereby authorized to label detector cells, containing licensed material and used in gas chromatography devices, with conspicuously etched or stamped radiation caution symbols.

16. Maintenance, repair, cleaning, replacement and disposal of foils contained in detector cells shall be performed only by the device manufacturer or other persons specifically authorized by the Commission or an Agreement State to perform such services.

17. A. Detector cells containing a titanium tritide foil or a scandium tritide foil shall only be used in conjunction with a properly operating temperature control mechanism which prevents the foil temperature from exceeding that specified by the manufacturer and approved by NRC.

    B. When in use, detector cells containing a titanium tritide foil or a scandium tritide foil shall be vented to the outside.

18. Each source holder or logging tool containing radioactive material shall bear a legible and visible marking as specified in 10 CFR 39.31(a). The label must be on the smallest component that contains the licensed material which is transported as a separate piece of equipment.

19. Licensed material shall not be used in or on human beings.

20. The licensee shall not use licensed material in field applications where activity is released except as provided otherwise by specific condition of this license.

21. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under the license.

22. The licensee is authorized to transport licensed material only in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

23. The licensee shall maintain records of information related to decommissioning at 944 East Harmon Avenue, Chemistry Building; Las Vegas, Nevada as specified in 10 CFR 30.35(g), 40.36(f), and 70.25(g) until this license is terminated by the Commission.

24. In addition to the possession limits in Item 8, the licensee shall further restrict the possession of licensed material to quantities below the minimum limit specified in 10 CFR 30.35(d) or 40.36(b) or 70.25(d) for establishing decommissioning financial assurance.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number
27-05861-02

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25. Notwithstanding the requirements of 10 CFR 20.202(c), the licensee may use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

26. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Application dated January 3, 1989
B. Letter dated March 13, 1989
C. Letter dated April 19, 1990
D. Letter dated July 26, 1990
E. Letter dated October 15, 1990
F. Letter dated November 9, 1990
G. Letter dated May 8, 1991
H. Letter dated December 19, 1991
I. Letter dated January 7, 1992
J. Letter dated April 7, 1992
K. Telefacsimile dated April 29, 1992
L. Letter dated July 17, 1992
M. Letter dated July 27, 1993
N. Letter dated September 7, 1993
O. Letter dated November 12, 1993
P. Letter dated August 19, 1994
Q. Letter dated October 5, 1994
R. Letter dated October 12, 1994
S. Letter dated April 7, 1995
T. Letter dated April 20, 1995
U. Letter dated November 9, 1995

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date NOV 2 8 1995

By James L. Montgomery
Materials Branch
Region IV, WCFO
Walnut Creek, California 94596

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

September 27, 1996

MEMORANDUM TO: Donald A. Cool, Director
Division of Industrial and Medical Nuclear Safety, NMSS

FROM: Frank A. Wenslawski, Chief
Materials Branch

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS
CONTROL 571951

This Technical Assistance Request (TAR) was originally submitted on July 10, 1996. The issue was whether an exemption from what is now 10 CFR 20.1501(c) can be continued when the license is renewed (the license is in timely renewal status).
License Condition 25. currently allows the licensee to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

In your response of September 4, 1996, you indicated that the exemption should not be renewed unless the licensee provides a sufficiently strong reason for continuing the exemption. Reasons cited for possible continuation of the exemption included requirements that the licensee be DOELAP accredited or inordinately high financial burdens involved in obtaining NVLAP accreditation. You also stated that the DOELAP accreditation would be recognized until it expires, and then NVLAP accreditation should have been obtained.

Upon receipt of your memorandum, Beth Prange of my staff contacted the licensee to discuss your concerns, as stated in the TAR response. To document the telephone conversation and to formally forward your concerns, a letter was forwarded to the licensee on September 12, 1996. A copy of that letter is enclosed with this TAR.

In response to the September 12, 1996 letter, the licensee submitted the enclosed reply dated September 19, 1996. That document indicates that EPA Las Vegas is constrained to be DOELAP accredited by an Interagency Agreement. It also states that the anticipated costs to become NVLAP certified are on the order of $10,000.00. Further, it is their contention that the DOELAP criteria are more stringent than those of NVLAP. The NVLAP accreditation certificate supplied with the response indicates an expiration date of November 1, 1996.

The licensee provided names and telephone numbers of technical staff who can answer questions regarding the DOELAP accreditation program. We do not object to you contacting them directly to discuss these matters, although we would appreciate being kept informed.

We are asking you to reconsider their original exemption request, in light of the additional information submitted. We recommend that the exemption be renewed. If this is not possible, please provide the reasoning.

If further information is required, contact Beth Prange at (510) 975-0250, or contact the licensee representatives directly.

Enclosures:

TAR Form dated September 27, 1996
Letter dated September 19, 1996
Letter dated September 12, 1996
Memorandum dated September 4, 1996
Memorandum dated July 10, 1996
TAR Form dated July 9, 1996
Letter dated July 3, 1996
Handbook for the DOELAP for Personnel Dosimetry Systems
DOE Standard for the Performance Testing of Personnel Dosimetry Systems
Amendment No. 22 to License No. 27-05861-02

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Docket File (w/first 3 encl only)
WCFO Inspection File (w/first 3 encl only)
LFARB, T-9 E10 (w/first 3 encl only)

chrono file

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BPrange BAP		FWenslawski							
09/26/96		09/27/96		09/ /96		09/ /96		09/ /96	

OFFICIAL RECORD COPY

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: September 27, 1996

Mail or E-Mail to: Donald A. Cool, Mail Stop: TWFN 8F5 If E-mail, cc: DAC
Division of Industrial and Medical Nuclear Safety, NMSS

From: Frank A. Wenslawski (FAW) Region IV, WCFO
Chief, Materials Branch

Licensee: EPA, Las Vegas License No.: 27-05861-02

Control No. 571951

Letters dated: September 12 and 19, 1996, enclosed

☐ Problem/Issue: The licensee requests renewal of an exemption from what is now 10 CFR 20.1501(c) to allow them to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP). They have submitted information to demonstrate that they are required to maintain DOELAP accreditation, and that it would involve a significant financial burden to become NVLAP certified.

☐ Action Required: Reconsider the licensee's request (originally submitted July 3, 1996) and determine whether the exemption can be continued in light of additional information. If not, specify the reasoning.

Recommended Action (with revisions): X Approve

Headquarter Reviewer: (For HQ use)
Regional Reviewer: Beth Prange (BAP1)
Reviewer Code: W1
Reviewer Phone No.: (510) 975-0250 FAX No.: (510) 975-0381
Request Needed by: 10/21/96

Form TAR-10
9/93

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

96 SEP 23 AM 9:16

September 19, 1996

OFFICE OF
RESEARCH AND DEVELOPMENT

U.S. Nuclear Regulatory Commission
Region IV
ATTN: Beth Prange
Sr. Health Physicist (Licensing)
Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

Dear Ms. Prange:

This is in response to your letter dated September 12, 1996 (refer to mail control number 57951, regarding exemption request, dated July 3, 1996), which requested submission of the reasons our exemption request should be continued.

The Office of Radiation and Indoor Air, Radiation Sciences Laboratory in Las Vegas (ORIA, RSL - LV) processes dosimeters predominantly associated with U.S. Department of Energy (DOE) activities. RSL - LV processes dosimeters for eight radiation workers (covered under NRC license), seven for the ORIA - LV and one for the National Exposure Research Laboratory in Las Vegas (NERL - LV); for forty-five occupational workers, eleven for NERL - LV and thirty-four for ORIA - LV. In addition, we act as a back-up to the Nevada Test Site (NTS) External Dosimetry Personnel Monitoring Program, which includes the Federal Radiological Monitoring and Assessment Center (FRMAC) and other radiological emergency response activities.

Providing external dosimetry for DOE in the areas around the NTS, including both environmental and personnel TLDs, requires Department of Energy Laboratory Accreditation Program (DOELAP) accreditation. The financial burden we would incur if required to apply for National Voluntary Laboratory Accreditation Program (NVLAP) accreditation and associated fees would be excessive, amounting to approximately $10,000.00 for the application plus personnel time.

Currently we are DOELAP accredited in categories I, II, IIIA, IV, and VII. The performance testing criteria for DOELAP exceed those of NVLAP for all categories except categories I and II, for which the criteria are the same. Specifically, for both NVLAP and DOELAP the tolerance level (L) is the same (L = 0.3) for categories I and II (that is, category I, accidents, low-energy photon, and category II, accidents, high-energy photons). But for categories IIIA, IV and VII (Mixture Categories III + IV) , the DOE criteria are more strict.

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57951

Specifically, L for NVLAP is 0.5, whereas for DOELAP it is 0.. The more restrictive performance testing necessary to obtain DOELAP accreditation is preferable to maintain a higher standard of quality assurance and control. RSL - LV does not process dosimeters specifically for beta or neutrons.

In summary, our program would be best served from a financial and quality assurance point of view if we were to receive an exemption.

If you or other NRC staff have technical questions, we would be pleased to host a telephone conference call at which our staff would answer questions. This might facilitate your review of this request, and avoid the lost time associated with exchanging letters.

Enclosed is the copy of our DOE interagency agreement you requested. If you require further clarification in this matter, please do not hesitate to contact Anita Mullen at (702) 798-2597, or Christopher Fontana at (702) 798-2429.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director
Characterization Research Division

Enclosure

wo/enclosure
cc: Loyd Carroll
Chrisitian Daughton
Anita Mullen
Paul Weeden

DE-AIO8-96NV11969
INTERAGENCY AGREEMENT (IA) BETWEEN
THE U.S. DEPARTMENT OF ENERGY
AND
THE U.S. ENVIRONMENTAL PROTECTION AGENCY

FUNDS-OUT IA

This IA consists of the following:

IA Face Page

Article	I	Purpose
Article	II	Scope of Work
Article	III	Costs, Support Level, Budgeting, and Finance
Article	IV	Deliverables/Reports
Article	V	Duration of Agreement
Article	VI	Program Officers
Article	VII	Obligation of Funds
Article	VIII	Payment
Article	IX	Classification
Article	X	Property Fire Protection
Article	XI	Documents Attached and Part of this Agreement
Article	XII	Documents Incorporated by Reference

571951

I. PURPOSE

The purpose of this Agreement is to define respective responsibilities of the parties. This Agreement will be administered on behalf of the U.S. Department of Energy (DOE) by the Nevada Operations Office (DOE/NV), or any representative or representatives designated by the Contracting Officer (see Item 6 of Face Page). This Agreement will be administered on behalf of the U.S. Environmental Protection Agency by the Office of Radiation and Indoor Air (EPA/ORIA)(see Item 7 of Face Page). The EPA/ORIA provides radiological and non-radiological sampling and analytical capabilities required for compliance with DOE requirements, as well as Clean Air Act/National Emission Standards for Hazardous Air Pollutants (NESHAP, 40 CFR 61) and Clean Water Act (CWA, 40 CFR 161).

II. SCOPE OF WORK

a. General

This Agreement recognizes that both the EPA/ORIA and DOE have statutory responsibilities which are not limited or affected by this Agreement. This agreement covers those services EPA/ORIA will perform in connection with the DOE Stockpile Stewardship and Test Readiness Program and other DOE/NV activities, including providing assistance in DOE Nevada Test Site special projects, emergency preparedness (CONUS and OCONUS), and training. The scope of such services to be performed will be as requested by the DOE and within the limitation of the particular DOE program funds in fulfillment of DOE's statutory responsibilities and as agreed to by EPA/ORIA, within its capabilities and statutory limitations.

EPA/ORIA will provide radiological and non-radiological sampling capabilities for NTS and other facilities managed by DOE/NV. Sampling will consist of sampling stations at nearby cities and rural locations in accordance with appropriate DOE/NV guidelines, NESHAP (40 CFR 61), and CWA (40 CFR 161). Sampling will include, but not be limited to, the following: Air Particulates, Tritium-in-Air, Ground Water Monitoring, Milk, Pressurized Ion Chambers (PIC), Thermoluminescent Dosimetry (TLD). The EPA/ORIA is also to produce reports of the data available from previous historical sampling regimens as well as producing sampling report data for the DOE/NV Annual Site Environmental Report (ASER) each year. The EPA/ORIA will also provide similar data reports to support the NESHAP Annual Report. The EPA/ORIA will also provide "Down-Hole" sampling capabilities to the On-Site Radiological Environmental Monitoring Plan. The EPA/ORIA will provide emergency/accident sampling capabilities for DOE/NV as well as cross-check Quality Assurance and Quality Control programs as requested. The EPA/ORIA will act as the

backup dosimetry laboratory for the DOE prime contract dosimetry laboratory in emergency situations. The EPA/ORIA will also serve to provide environmental analytical/management services as requested by DOE/NV.

b. Radiological Environmental Monitoring Program

The EPA/ORIA will provide radiological environmental monitoring programs which include activities requested by DOE such as Stockpile Stewardship and Test Readiness Support, Special NTS Project Support, long term hydrological monitoring, dosimetry, and laboratory capabilities. EPA/ORIA will provide a panel member to the Experiment Controller. Programs will be staffed by qualified scientists and supporting personnel. Programs will be conducted in accordance with applicable federal regulations, DOE Orders, and industry standards.

c. Non-Radiological Monitoring

The EPA/ORIA will carry out public notification and will assist in evacuation programs as required by nonradiological effects of DOE/NV testing programs at any location. These programs will be with specific procedures mutually agreed upon by the EPA/ORIA, DOE/NV, and in consent with state officials. EPA/ORIA will provide a safety panel member to the Operations Controller at the Hazmat Spill Center (HSC) for project support. EPA/ORIA will provide nonradiological monitoring support at the HSC. Funding is provided by users utilizing the HSC and is separate from this agreement.

d. Quality Assurance Program

(1) The EPA/ORIA will develop, implement, and maintain a comprehensive Quality Assurance Program (QAP) and will comply with all applicable policies, regulations, requirements, and standards of the DOE as agreed appropriate by the DOE and EPA/ORIA, provided they do not conflict with EPA/ORIA regulations and statutory requirements. The EPA/ORIA's QAP will be structured in a manner to provide overall quality assurance (QA) policies and requirements for the work performed on the IA. The EPA/ORIA's overall QAP is auditable by the DOE/NV.

(2) For all work under this IA, the EPA/ORIA will include in all of its contracts, subcontracts, and consulting agreements, the substance of this QA provision, except for items and activities determined inappropriate by the EPA/ORIA.

e. Community Technical Representative Program

The EPA/ORIA will provide a comprehensive program designed to provide information and assistance to individual citizens, organizations, and local government agencies in communities near the NTS. The program will enhance communications with the public through hiring and training of local residents as Community Technical Representatives (CTR) or Alternate Community Technical Representatives (ACTR) and through developing and maintaining contacts and communications with community leaders and others. The EPA/ORIA will schedule, coordinate, and participate in public education forums as requested or required to maintain a viable program and assist in the ongoing training program for the CTRs and ACTRs. Data collection and analysis procedures will be provided, as well as interpretation and reporting of the data.

III. COSTS, BUDGETING, AND FINANCE

a. Costs

The total estimated cost for accomplishing the IA Statement of Work requirements for five years is as follows:

Direct and Indirect Costs	$15,000,000
Capital Equipment	-0-
Total	$15,000,000

b. Support Level

EPA shall authorize a maximum of 62 full time equivalent positions (FTE's) in support of the DOE programs. However, due to budget constraints placed on DOE it is understood that all FTE's will not necessarily be funded.

c. Work Plan and Budget

The parties will agree annually as to the scope of work to be performed during the period covered by the Agreement and costs thereof and the amount agreed to will be set forth in a modification to this Agreement. EPA/ORIA will provide a management

plan with appropriate budget estimates in sufficient time to be incorporated in DOE/NV annual budget requests.

d. Cost Reporting

EPA/ORIA will submit to DOE/NV monthly reports of the costs incurred in the performance of the work hereunder, by COB on the fourth workday following the end of the reporting month. Such reports will indicate accrued costs incurred for each DOE Budget and Reporting Classifi on or other similar cost category. Both current month and fiscal year-to-date cumul..ve costs will be reported on forms supplied by DOE/NV. Since EPA/ORIA accounting is obligation-expenditure (as opposed to accrued cost) based, obligations for all payroll and related costs and for transactions of less than $10K each for obligations falling under other OMB Object Classifications are considered for this purpose to be costs incurred. Nonpayroll obligations greater than $10K are not to be reported as costs until the goods/services in question are actually received (this does not affect billings--see paragraph d. below). A listing of obligations thus deferred (uncosted obligations) will be attached to each monthly cost report. Allocations of overhead are also to be included in the monthly costs reported. These overhead costs will be allocated to each of the costs categories specified above.

e. Cost Reimbursement

EPA/ORIA will be reimbursed monthly for obligations incurred, as required by EPA/ORIA Headqua.ters policy. Reimbursements will be accomplished via the Department of Treasury On-line Payment and Collection System (OPAC). Differences (both increases and decreases) between obligations and related actual expenditures will be included in the monthly billing/collection process as they become known. Amounts billed will be segregated into two main categories, direct and indirect ... dard OMB Object Classifications reported within each.

f. Cost and Commitment Limitations

The tasks under this IA are funded from various DOE program resources. This makes it necessary to require cost and commitment limitations (ceilings) for each program resource. A "Cost and Commitment Limitations Schedule" will be included as part of each IA modification that obligates or deobligates funds. The individual "Current Cost and Commitment Ceiling" amounts identified in that schedule cannot be exceeded. The EPA/ORIA will monitor costs incurred and commitments for each individual program resource and notify the DOE/NV Contracting Officer and the Resources Management Division in writing whenever current ceiling amounts are projected to be exceeded or substantially underrun. DOE/NV will then either revise

the scope of work under the IA or adjust the various funding levels. Reimbursement of costs incurred will be limited to the "Current Cost and Commitment Ceiling" specifically identified in the IA.

IV. Deliverables/Reports

Participation in formal mid-year and year end budget/schedule briefings
Monthly Cost Reports
Annual Budget Estimate
Contribution to Annual Environmental Report
Contribution to NESHAP Annual Report
Interim Test Reports
Monthly Performance Measurement System Report
Monthly Project Tracking System Report
Such other reports as may be required from time to time

The performing agency will deliver three copies of all reports to the DOE/NV Program Officer at the address shown, see Block 6, Face Page.

V. Duration of Agreement

See Block 4, Face Page.

VI. Program Officers

DOE and performing agency--see Blocks 6 and 7, Face Page.

VII. Obligation of Funds

The total amount presently obligated by the DOE/NV is $522,163.

No other agency has obligated funds under this Agreement.

VIII. Payment

Reimbursement will be accomplished via the Department of Treasury On-Line Payment and Collection System (OPAC). Monthly cost reports will include the following information:

A. DOE Accounting Appropriation Data, see Block 5(a), Face Page.

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21, P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $522,163. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

APPENDIX A
STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT
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APPENDIX A

STANDARD GENERAL PROVISIONS
FOR
DOE FUNDS-OUT INTERAGENCY AGREEMENT

1. Definitions. For purposes of this Agreement, "DOE" means the United States Department of Energy or any duly authorized representative thereof, and "Agency" means the performing agency stated in the Agreement of any duly authorized representative thereof.

2. Cost Chargeable to DOE Funds. Direct costs are the costs that can be directly identified with and charged to the work under the Agreement and within the limitations set forth below. Examples of such costs are salaries, technical services, materials, travel and transportation, communications, and any facilities and equipment expressly approved for purchase under the Interagency Agreement.

   a. Foreign travel costs are allowable only when approved by DOE.

   b. Reimbursement for expenditures at technical meetings and seminars at which attendance is not required by DOE will not be allowable without prior written approval of the DOE Contracting Officer.

3. Financing. DOE will finance programs on a reimbursable basis when acceptable to the other agency. If the reimbursable basis is not acceptable, however, then DOE will finance the work by a Consolidated Working Fund Advance, preferably on a quarterly basis, or by an appropriation transfer or transfer appropriation. DOE will reimburse or will make available, in advance, the amount specified in the Interagency Agreement incorporating these general provisions. Requests for funds will show separately the amount required for (a) operating costs, (b) capital equipment (as defined in 9 below), (c) acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

   a. Vouchers for payment will be submitted on the agreed upon form.

   b. Any funds advanced which are expected to remain beyond the original period of performance for a program/project which is incomplete, of for which there is an increased scope of work, will remain available to the Agency if the IA is amended by the DOE to extend the period of performance for the research program/project or any other work beyond the original completion date. Request for such time extensions should be made to the DOE by the Agency at least 30 calendar days prior to the end of the performance period.

c. Any advanced funds remaining for a continuing research project or any other work remain available for the entire performance period of the project, unless there is a date specified as a required completion date after which no further funds will be expended.

d. Any advanced funds remaining after the completion of a research program/project will be reimbursed to the DOE.

4. Notice of Costs Approaching Total Estimated Costs. Whenever the Agency has reason to believe that the total cost of the work under this Agreement will be substantially greater or less than the presently estimated cost of the work, the Agency will promptly notify the DOE in writing. The Agency will also notify the DOE, in writing, when the aggregate of costs incurred and outstanding commitments allowable under this Agreement is equal to 90 percent (or such other percentage as the DOE may from time to time establish by notice to the Agency) of the presently estimated total costs under this Agreement. When the costs incurred and outstanding commitments equal 100 percent of such estimated total costs, the Agency will make no further commitments or expenditures (except to meet existing commitments) and will be excused from further performance of the work unless and until the DOE will increase the total estimated costs to be incurred with respect to this Agreement.

5. Excess Funds. The Agency will take prompt action to return to the DOE any funds determined to be excess to the work during the performance of the work and any unobligated funds after the completion of the Agreement or as of September 30 each year unless the Agreement has been extended and any unused balances have been carried forward in the extension. In a joint venture project where the performing Agency deposits the advance in any annual consolidated working fund, any unobligated balances will be returned to the DOE before the cutoff date at the close of each fiscal year.

6. Financial Reports. The Agency will furnish the DOE, not later than four working days after the close of each reporting period, monthly or other periodic cost or financial reports in such form and details as may be required by the DOE. Any costs incurred for capital equipment or other assets will be supported by a list showing the description, make, any serial number, and the cost of each item acquired.

7. Accounting Records. The Agency will accumulate and account for obligations and costs incurred in connection with the work being performed under this Agreement in such form and detail as may be required by the DOE.

8. Termination. Either party may terminate this Agreement upon 30 calendar days written notice of such termination addressed to the other party. In the event of such termination, the Agency will be reimbursed, to the extent permitted, for obligations actually incurred to the effective date of termination and for commitments extending beyond the effective date of

termination to a date not later than the date upon which the Agreement would have expired if not terminated under this paragraph, which the Agency, in the exercise of due diligence, is unable to cancel. Payments under this Agreement, including payments under this article, will not exceed the ceiling amount elsewhere specified in the Agreement.

9. Capital Equipment

a. "Capital Equipment" means each item of equipment which is expected to have an extended period of service, generally two years or more, and has sufficient monetary value, generally of $5,000 or more, to justify continuing accounting records for the item.

b. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the procurement or fabrication of capital equipment.

c. If capital equipment is purchased or otherwise acquired pursuant to an authorization under Paragraph (b) above, except as may be otherwise agreed by the DOE and the Agency:

(1) the title thereto will vest in the DOE;

(2) the Agency will be responsible for the maintenance and safeguarding thereof; and

(3) the Agency will maintain a record in such a manner as to ensure adequate control and accounting satisfactory to the DOE, of capital equipment procured or fabricated.

10. Real Property and Facilities

a. Unless expressly authorized by the Contracting Officer in advance, the Agency will not be reimbursed or use funds made available under this Agreement for the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion.

b. If the Agency acquires or condemns any real property or any facility or acquires, constructs, or expands any plant or facility pursuant to an authorization under (a) above, except as may be otherwise agreed by the DOE and the Agency:

(1) the title thereto will vest in the DOE, and property accountability and control will become the responsibility of DOE;

(2) the Agency will be responsible for the maintenance and safeguarding thereof; and

(3) the Agency will maintain a record thereof in such a manner as to ensure adequate control and accounting satisfactory to the DOE.

11. Patents. It is understood and agreed by DOE and the Agency that the patent policy to be employed in any particular undertaking under this Agreement between the parties, which includes research, development, or demonstration work and is supported by DOE funding, will be set forth in Appendix B.

12. Security of Restricted Data

a. Contracting Agency's duty to safeguard Restricted Data, Formerly Restricted Data, and other classified information. The Agency will, in accordance with DOE security regulations and requirements, be responsible for safeguarding Restricted Data, Formerly Restricted Data, and other classified information and protecting against sabotage, espionage, loss and theft, the classified documents and material in the Agency's possession in connection with the performance of work under this Agreement. Except as otherwise expressly provided in the Agreement, the Agency will upon completion or termination of this Agreement, transmit to DOE any classified matter in the possession of the Agency or any person under the Agency's control in connection with performance of this Agreement. If retention by the Agency of any classified matter is required after the completion or termination of the Agreement and such retention is approved by the DOE, the Agency will complete a certificate of possession to be furnished to DOE specifying the classified matter to be retained. The certification will identify the items and types or categories of matter retained, the conditions governing the retention of the matter and the period of retention, if known. If the retention is approved by the DOE, the security provisions of the Agreement will continue to be applicable to the matter retained.

b. Regulations. The EPA/ORIA will furnish to the DOE/NV Safeguards and Security Division copies of its periodic inspection reports or periodic memoranda covering the DOE/NV classified interest, citing that a satisfactory survey was conducted.

c. Definition of Restricted Data. The term "Restricted Data," as used in this clause, means all data concerning: (1) design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but will not include data declassified or removed from the restricted data category pursuant to Section 142 of the Atomic Energy Act of 1954.

d. Definition of Formerly Restricted Data. The term "Formerly Restricted Data," as used in this clause, means all data removed from the Restricted Data category under Section 142d of the Atomic Energy Act of 1954, as amended.

e. Security Clearance of Personnel. The Agency will not permit any individual to have access to Restricted Data, Formerly Restricted Data, or other classified information, except in accordance with the Atomic Energy Act of 1954, as amended, and the DOE's regulations or requirements applicable to the particular type or category of classified information to which access is required.

f. Criminal Liability. It is understood that disclosures of Restricted Data, Formerly Restricted Data, or other classified information relating to the work or services ordered hereunder to any person not entitled to receive it, or failure to safeguard any Restricted Data, Formerly Restricted Data, or any other classified matter they control in connection with work under this Agreement, may subject any representatives of the Agency, its agents, employees, or subcontractors to criminal liability under the laws of the United States. (See the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.; 18 U.S.C. 793 and 794; and Executive Order 12356.)

g. Contracts and Purchase Orders. Except as otherwise authorized in writing by DOE, the Agency will insert provisions similar to the foregoing in all applicable contracts and purchase orders under this Agreement.

h. Security Requirements for Proprietary Energy Data. The Agency will safeguard DOE official use information, or other proprietary or sensitive data (including material relating to patents), from unauthorized access, disclosure, modification, or destruction in accordance with applicable DOE security regulations and applicable orders and directives.

I. Computer Security Requirements. In the event this Agreement involves utilization of a DOE computer system, the Agency will establish administrative, technical, and physical security procedures in accordance with applicable DOE regulations, to ensure against access to DOE information to individuals not formally authorized by the DOE to possess such information.

13. Classification. The classification function under this IA will be performed by the Agency in accordance with applicable DOE regulations, orders, directives, and guidance.

a. All documents and material originated or generated by the Agency concerning potentially classified subject areas will receive appropriate classification review by the Agency. Classification determinations will be based upon classification guidance furnished by the DOE.

b. Every contract, subcontract, and purchase order issued hereunder involving the origination or generation of classified documents or material, will include a provision to

the effect that prior to the performance of such contract, subcontract, or purchase order, the contractor, subcontractor, or supplier must submit a request to the Agency requesting the appointment of an Authorized Classifier(s) by the DOE. Classification determinations will be based upon classification guidance furnished by the Agency or DOE.

14. Technical Information Products: Review and Publication. The Agency will make reports to the DOE on the progress of the work under this Agreement as may be mutually agreed upon. It is the policy of DOE to make the results of the research, development, and demonstration work contemplated under IA's broadly available to the scientific, technical, and engineering community and others through the timely publication or reports or journal articles.

    a. When conducting research under this IA, the Agency will complete form DOE F 538, "Notice of Energy R&D Project," and forward to the DOE Office of Scientific and Technical Information (OSTI), AD-21. P. 0. Box 62, Oak Ridge, TN 37831.

    b. All technical information products for public release will be reviewed by the DOE Technical Information Officer. Technical reports will be prepared in accordance with DOE Order 1430.2.

    c. All technical information products prepared under the IA will be freely exchanged, made available for public sales, unless classified, and a minimum of two copies sent to the DOE OSTI, AD-21, P. 0. Box 62, Oak Ridge, TN 37831. Each IA technical report issued will be sent to OSTI, accompanied by DOE Form 1332.15, to be held in the DOE archives and made available to the DOE community.

15. Environmental Safety and Health Requirements. DOE will assume responsibility for prescribing and/or enforcing environmental, safety, and health requirements for operators of other Agency facilities engaged in the performance of DOE work on department sites or in facilities under DOE control.

16. Obligation of Funds. The amount presently obligated by the Government with respect to this Agreement is $97,233. Such amount may be increased or decreased by written agreement of the parties. Nothing in this paragraph is to be construed as authorizing the Agency to exceed limitations stated in the Cost and Commitment Limitations Schedules established by DOE and furnished to the Agency from time to time under this Agreement.

17. Inspections and Audits. DOE will at all times have access to the facilities and records of the Agency pertaining to the work under this Agreement for the purposes of inspection and audit, and the Agency will provide DOE with facilities for such inspection and audit.

18. Transition From Former Agreement.

a. Agreement No. DE-AIO8-96NV11969 effective September 1, 1996, supersedes Agreement No.DE-AI08-91NV10963.

b. On and after September 1, 1996, all rights and obligations of the parties with respect to work described herein will be governed by the provisions of Agreement No. DE-AIO8-96NV11969.

c. The rights and obligations of the parties which have been incurred or which have accrued or matured under the provisions of Agreement No. DE-AI08-91NV10963 on or prior to September 1, 1996, will in nowise be impaired, limited, enlarged, or affected by reason of the provisions of this Agreement.

d. All materials, tools, machinery, equipment, supplies, and other property; all drawings, designs, specifications, and other engineering, technical, scientific, operating data, and records furnished to or acquired or generated by the Agency in connection with work under Agreement No. DE-AI08-91NV10963, to the extent that they are in the custody or possession of the Agency on the effective date of this Agreement, will remain in the custody or possession of the Agency for use in connection with the work under this Agreement, unless otherwise directed by the Contracting Officer.

e. All purchase orders, subcontracts, leases, licenses, permits, and other contractual commitments with third parties entered into pursuant to Agreement No. DE-AI08-91NV10963, and outstanding on September 1, 1996, will continue in effect for use in connection with the work to be performed under this Agreement unless otherwise directed by the Contracting Officer, and the reimbursement of costs incurred thereunder after September 1, 1996, will be subject to the provisions of this Agreement.

f. Subject to the foregoing paragraphs, all of the rights and obligations of the parties under Agreement No.DE-AI08-91NV10963, are assigned and transferred from said Agreement No. DE-AI08-91NV10963 to this Agreement No. DE-AIO8-96NV11969 and made a part hereof by this reference as though full set out herein. Subject to the other provisions of this Agreement, any costs associated with the transition from Agreement No. DE-AI08-91NV10963 to Agreement No. DE-AIO8-96NV11969 will be allowable cost.

APPENDIX B

INTELLECTUAL PROPERTY

Patents.

It is understood and agreed by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (Agency) that the Intellectual Property Rights policy to be employed in any particular cooperative undertaking between the parties pursuant to this Interagency Agreement (IA) which is supported in whole or in part by DOE/NV funding will be as set forth below:

(a) In any contract, subcontract, or task order under a contract where the Agency has research, development, or demonstration (R,D&D) work performed by a contractor (other than a small business firm or nonprofit organization) and the work is not severable from that funded by the Agency, the Agency will incorporate the Patent Rights clause of 48 C.F.R. Section 952.227-13, dated March 1995. Where, however, the contract, subcontract, or task order is with a small business firm or nonprofit organization, the Patent Rights clause used in the contract will be in accordance with the provisions of P.L. 96-517. Patent Rights clause at 48 C.F.R. 952.227-11, dated March 1995, will be incorporated in the latter contracts.

(b) Offerors and prospective contractors (other than small business firms or nonprofit organizations) shall be provided with notice of and the opportunity to request at any time prior to the effective date of the contract or within 30 days thereafter, an advance waiver of all or any part of the rights of the United States with respect to inventions which may be conceived or first actually reduced to practice in the course of or under a cost shared contract. The clause at 48 C.F.R. 952.227-84, dated April 1984, may be used for this purpose. The Agency Contracting Officer will promptly forward such requests to DOE's Assistant General Counsel for Patents and will notify the contractor whether such request is granted in whole or in part.

(c) When the Agency has the work performed by Agency contractors, subcontractors, or consultants via contracts or subcontracts under this IA, funded in whole or in part by DOE, the contract or subcontract will incorporate, as the Intellectual Property Rights provisions, the DOE Patent and Data Supplement to Part II--Contract Clauses DOE Set 304, dated December 22, 1995, clauses 50 through 57, for cost reimbursement service contracts and DOE Set 301S, dated December 22, 1995, clauses 46 through 54, for fixed price service contracts. Copies of these clause sets may be accessed via the Internet through the DOE Home Page and will be made available, upon request, from the DOE/NV Contracting Officer.

(d) Where an Agency contractor, subcontractor, or consultant will not accept the Intellectual Property Rights provisions provided by DOE, the Agency will not proceed with the

contract or subcontract without written approval of the DOE Patent Counsel.

(e) When the Agency has the work performed by Agency personnel, any inventions or discoveries made or conceived in the course of or in connection with such work will be reported and processed in accordance with the standard Agency procedure. However, the Agency will also report all such inventions to the DOE/NV and obtain DOE/NV's concurrence prior to making any determination in which the Government would retain less than the entire right, title, and interest to any such invention made by an Agency employee.

(f) DOE will have unlimited rights, as that term is defined in FAR 52.227-14, to any technical data generated during the performance of work under this IA. However, it is recognized that during the course of the work, the Agency or its employees, consultants, or contractors may from time to time desire to publish, within the limits of security requirements, information regarding scientific or technical developments made or conceived in the course of or under this IA. In order that public disclosures of such information will not adversely affect the Intellectual Property interests of DOE or the Agency, patent clearances and requests to establish copyright will be secured from DOE prior to any such release or publication. Otherwise, all generated technical reports and/or other engineering materials prepared under this IA will be freely exchanged and made available to the DOE/NV Contracting Officer for release to the public unless classified or restricted.

PART II
Contract Clauses

DOE List 304 – Cost Reimbursement Service Contracts

1.	FAR	52.252-2	Clauses Incorporated by Reference (JUN 1988) This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available.
2.	FAR (OCT 1995) DEAR (APR 1994)	52.201-1 952.202-1	Definitions
3.	FAR	52.203-3	Gratuities (APR 1984)
4.	FAR	52.203-5	Covenant Against Contingent Fees (APR 1984)
5.	FAR	52.203-6	Restrictions on Subcontractor Sales to the Government (OCT 1995)
6.	FAR	52.203-7	Anti-Kickback Procedures (JUL 1995)
7.	FAR	52.203-9	Requirement for Certificate of Procurement Integrity-Modification (SEP 1995)
8.	FAR	52.203-10	Price or Fee Adjustment for Illegal or Improper Activity (SEP 1990)
9.	FAR	52.203-12	Limitation on Payments to Influence Certain Federal Transactions (JAN 1990) *Applicable only if the contract estimated cost, including fee, exceeds $100,000.*
10.	FAR	52.204-4	Printing/Copying Double-Sided on Recycled Paper (MAY 1995)
11.	DEAR	952.208-70	Printing (APR 1984)
12.	FAR	52.209-6	Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (JUL 1995)
13.	DEAR	952.212-72	Uniform Reporting System (MAY 1987)
14.	FAR	52.215-2	Audit and Records-Negotiation (OCT 1995), Alternate II (OCT 1995) *Alternate II applies if the contract is with an educational institution.*
15.	FAR	52.215-22	Price Reduction for Defective Cost or Pricing Data (OCT 1995)
16.	FAR	52.215-23	Price Reduction for Defective Cost or Pricing Data-Modifications (OCT 1995)
17.	FAR	52.215-24	Subcontractor Cost or Pricing Data (OCT 1995)
18.	FAR	52.215-25	Subcontractor Cost or Pricing Data-Modifications (OCT 1995)
19.	FAR	52.215-26	Integrity of Unit Prices (OCT 1995), Alternate I (APR 1991). *Alternate I applies if the contract is not the result of full and open competition.*

20.	FAR	52.215-27	Termination of Defined Benefit Pension Plans (MAR 1996)
21.	FAR	52.215-30	Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
22.	FAR	52.215-31	Waiver of Facilities Capital Cost of Money (SEP 1987) *This clause applies to this contract only if the contract is subject to the cost principles for contracts with commercial organizations, Subpart 31.2.*
23.	FAR	52.215-33	Order of Precedence (JAN 1986)
24.	FAR	52.215-40	Notification of Ownership Changes (FEB 1995) *This clause applies if certified cost or pricing data have been submitted or if any preaward or postaward cost determination is subject to FAR subpart 31.2.*
25.	FAR	52.215-42	Requirements for Cost or Pricing Data or Information Other Than Cost or Pricing Data-Modifications (OCT 1995), Alternate IV (OCT 1995)
26.	DEAR	952.216-7	Allowable Cost and Payment (DEC 1991), Alternates I AND II
27.	FAR	52.216-8	Fixed Fee (APR 1984) *This clause applies to this contract only if the contract makes provision for the payment of a fixed fee.*
28.	FAR	52.216-11	Cost Contract-No Fee (APR 1984) *This clause applies to this contract only if the contract makes no provision for the payment of a fee.*
29.	DEAR	952.217-70	Acquisition of Real Property (APR 1984)
30.	FAR	52.219-8	Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns (OCT 1995)
31.	FAR	52.219-9	Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (OCT 1995)
32.	FAR	52.219-16	Liquidated Damages-Subcontracting Plan (OCT 1995)
33.	FAR	52.222-1	Notice to the Government of Labor Disputes (APR 1984)
34.	FAR	52.222-2	Payment for Overtime Premiums (JUL 1990)
35.	FAR	52.222-3	Convict Labor (APR 1984)
36.	FAR	52.222-4	Contract Work Hours and Safety Standards Act-Overtime Compensation (JUL 1995) *Applicable to contracts which involve the employment of laborers or mechanics.*
37.	FAR	52.222-26	Equal Opportunity (APR 1984)
38.	FAR	52.222-28	Equal Opportunity Preaward Clearance of Subcontracts (APR 1984) *This clause applies to this contract only if the estimated cost, together with any fee, is $1,000,000 or more.*
39.	FAR	52.222-35	Affirmative Action for Special Disabled and Vietnam Era Veterans (APR 1984)
40.	FAR	52.222-36	Affirmative Action for Handicapped Workers (APR 1984)

41. FAR 52.222-37 Employment Reports on Special Disabled Veterans and Veterans of the Vietnam Era (JAN 1988)

42. FAR 52.222-41 Service Contract Act of 1965, as amended (MAY 1989)
Applicable if the principal purpose of the contract is to furnish services through the use of service employees as defined under Department of Labor regulations at Title 29, Code of Federal Regulations, Part 4.

43. FAR 52.222-42 Statement of Equivalent Rates for Federal Hires (MAY 1989)
Applicable if the clause at FAR 52.222-41, Service Contract Act of 1965 is applicable.

44. FAR 52.223-2 Clean Air and Water (APR 1984)
This clause applies to this contract only if the price is (a) in excess of $100,000; (b) a facility to be used has been the subject of a conviction under the applicable portion of the Air Act (42 U.S.C. 7413(c)(1)) on the Water Act (33 U.S.C. 1319(c)) and is listed by EPA as a violating facility; or (c) the acquisition is not exempt under FAR 23.104.

45. FAR 52.223-6 Drug-Free Workplace (JUL 1990)

46. FAR 52.223-14 Toxic Chemical Release Reporting (OCT 1995)

47. DEAR 952.224-70 Paperwork Reduction Act (APR 1984)

48. FAR 52.225-11 Restrictions on Certain Foreign Purchases (MAY 1992)

49. FAR 52.225-19 European Union Sanction for Services (JAN 1996)

50. FAR 52.227-1 Authorization and Consent (JUL 1995)
This clause applies only if so indicated elsewhere in this contract.

51. FAR 52.227-2 Notice and Assistance Regarding Patent and Copyright Infringement (APR 1984)
This clause applies only if the amount of this contract exceeds the dollar amount set forth in 13.000 of the Federal Acquisition Regulation.

52. DEAR 952.227-9 Refund of Royalties (MAR 95)

53. DEAR 952.227-11 Patent Rights-Retention by Contractor (Short Form) (MAR 1995)
This clause applies only if the contractor is a domestic small business or domestic nonprofit organization at the time of award.

54. DEAR 952.227-13 Patent Rights-Acquisition by the Government (MAR 1995)
This clause applies unless the Contractor is a domestic small business or domestic nonprofit organization at the time of award.

55. FAR 52.227-14 Rights in Data-General with Alternates I and V (JUN 1987)
This clause applies unless FAR 52.227-17 has been specified elsewhere in the contract.

55. FAR 52.227-16 Additional Data Requirements (JUN 1987)
This clause does not apply to this contract if the contract is for the conduct of basic or applied research, as set out elsewhere in this contract, to be performed solely by a college or university, and the estimated cost is not in excess of $500,000.

56. FAR 52.227-17 Rights in Data-Special Works (JUN 1987)
This clause applies only if specified elsewhere in the contract.

57. FAR 52.227-23 Rights to Proposal Data (Technical) (JUN 1987)

58. FAR 52.228-7 Insurance-Liability to Third Persons (MAR 1996)

59. FAR 52.232-17 Interest (JAN 1991)
This clause applies to this contract unless (1) the contractor is (a) a Federal Agency; (b) a State of local government or instrumentality; (c) a foreign government or instrumentality or (d) a nonprofit organization, and the contract makes no provisions for the payment of a profit or fee; or (2) the contract is one for paid advertisements pursuant to Subpart 5.5.

60. FAR 52.232-20 Limitation of Cost (APR 1984)
This clause applies to this contract if it is a fully-funded contract.

61. FAR 52.232-22 Limitation of Funds (APR 1984)
This clause applies to this contract if it is an incrementally-funded contract to which the final funding increment has not been allotted.

62. FAR 52.232-23 Assignment of Claims (JAN 1986)

63. FAR 52.232-25 Prompt Payment (SEP 1992)

64. FAR 52.232-28 Electronic Funds Transfer Payment Methods (APRIL 1989)

65. FAR 52.233-1 Disputes (OCT 1995), Alternate I (DEC 1991)

66. FAR 52.233-3 Protest after award (AUG 1989), and Alternate I (JUN 1985)

67. DEAR 952.235-70 Key Personnel (APR 1995)

68. FAR 52.242-1 Notice of Intent to Disallow Costs (APR 1984)

69. FAR 52.242-3 Penalties for Unallowable Costs (OCT 1995)
This clause applies if this contract is for an amount over $500,000.

70. FAR 52.242-13 Bankruptcy (JUL 1995)

71. FAR 52.242-15 Stop-Work Order-Alternate I (APR 1984)

72. FAR 52.243-2 Changes (Cost-Reimbursement) Alternates I and V (AUG 1987)
Alternate V applies if the purpose of the contract is research and development.

73. FAR 52.244-2 Subcontracts (Cost-Reimbursement and Letter Contracts) (MAR 1996)

74. FAR 52.244-5 Competition in Subcontracting (JAN 1996)

75. FAR 52.244-6 Subcontracts for Commercial Items and Commercial Components (OCT 1995)

76. DEAR 952.245-5 Government Property-Cost-Reimbursement, Time-and-Material, or Labor-Hour Contracts), Alternate I (JUL 1985)
Alternate I applies if the contract is for research at nonprofit institutions of higher education or other nonprofit organizations whose primary purpose is the conduct of scientific research as may be indicated in Section H of the contract.

78. FAR 52.246-5 Inspection of Services-Cost-Reimbursement (APR 1984)
This clause applies unless the contract is for research and development

79. FAR 52.246-8 Inspection of Research and Development (Cost-Reimbursement) Basic and Alternate I (APR 1984)

This clause applies if the contract is for the conduct of research and development. Alternate I applies if the contract is on a no fee basis.

80. FAR 52.246-25 Limitation of Liability-Services (APR 1984)

81. FAR 52.247-63 Preference for U.S.-Flag Air Carriers (APR 1984)

82. FAR 52.247-64 Preference for Privately Owned U.S.-Flag Commercial Vessels (JUL 1995)

83. DEAR 952.247-70 Foreign Travel (APR 1984)

84. FAR 52.249-5 Termination of the Government (Educational and Other Non-Profit Institutions) 8APR 1984)
This clause applies if the contract is for research and development work with an educational or nonprofit institution on a no-profit or no-fee basis.

85. FAR 52.249-6 Termination (Cost-Reimbursement) (MAY 1986)
This clause applies to this contract unless the contractor is an educational or nonprofit institution, and the contract makes no provision for the payment or a profit or fee.

86. FAR 52.249-14 Excusable Delays (APR 1984)

87. DEAR 952.251-70 Contractor Employee Travel Discounts (JUN 1995)

United States Environmental Protection Agency
Washington DC 20460

EPA

Interagency Agreement / Amendment

Part I - General Information

1. EPA / IAG Identification Number	4. Funding Location by Region
RW89937611-01-0	HQ
2. Other Agency ID Number	**5. Program Office Abbreviation**
DE-AI08-96NV11969	OAR/ORIA/RSL
3. Type of Action	
NEW PROJECT	

6. Name and Address of EPA Organization
ENVIRONMENTAL PROTECTION AGENCY
RADIATION SCIENCES LABORATORY
P.O. BOX 98517
LAS VEGAS, NV 89193-8517

7. Name and Address of Other Agency
ENERGY, DEPARTMENT OF
NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518

8. Project Title
TO PROVIDE CONTINUED SUPPORT TO ENVIRONMENTAL RESTORATION & WEAPONS PROGRAMS

9. EPA Project Officer (Name, Address, Telephone Number)
WEEDEN, PAUL J., DIRECTOR
EPA/OAR/ORIA/RSL
P.O. BOX 98517
LAS VEGAS, NV 89193-8517
(702) 798-2301

10. Other Agency Project Officer (Name, Address, Telephone Number)
MONROE, LESLIE A., EPD
DOE/NEVADA OPERATIONS OFFICE
P.O. BOX 98518
LAS VEGAS, NV 89193-8518
(702) 295-1744

11. Project Period
09/01/96 to 08/31/01

12. Budget Period
09/01/96 to 08/31/01

13. Scope of Work (Attach additional sheets, as needed)

SCOPE OF WORK ATTACHED

THE EPA GRANTS SPECIALIST FOR THIS IAG IS
FELICA A. TARVER, PHONE NO. 202-260-8277

14. Statutory Authority for Both Transfer of Funds and Project Activities
ECONOMY ACT OF 1932 AS AMENDED

15. Other Agency Type
FEDERAL AGENCY

FUNDS	PREVIOUS AMOUNT	AMOUNT THIS ACTION	AMENDED TOTAL
16. EPA Amount	0	0	
17. EPA In-Kind Amount	0	0	
18. Other Agency Amount	0	522,163	
19. Other Agency In-Kind Amount	0	0	
20. Total Project Cost	0	522,163	

21. Fiscal Information

Site Name	DCN	FY	Approp.	Budget Org.	Program Elem.	Object	Site/Project	Cost Org.	Obligation
		96	CR	33D0X01	RLU				522,163

Part II - Approved Budget

EPA IAG Identification Number: RW89937611-01-0

22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	350,000	350,000
(b) Fringe Benefits	0	0
(c) Travel	20,000	20,000
(d) Equipment	63,883	63,883
(e) Supplies	78,280	78,280
(f) Procurement / Assistance	10,000	10,000
(g) Construction	0	0
(h) Other	0	0
(i) Total Direct Charges	522,163	522,163
(j) Indirect Costs: Rate 0.00 % Base $ _____.	0	0
(k) Total: (EPA Share: 0.00 %) (Other Agency Share 100.00 %)	522,163	522,163

23. Is Equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? (Identify all equipment costing $1000 or more.) ☐ Yes ☒ No

24. Are any of these funds being used on extramural agreements? (See Item 22f.) ☒ Yes ☐ No

Type of extramural agreement ☒ Grant ☐ Cooperative Agreement ☒ Procurement (includes Small Purchase Order)

Contractor / Recipient Name (if known)	Total Extramural Amount under this Project	Percent Funded by EPA (if known)
VARIOUS	522,168	0.00

Part III - Funding Methods and Billing Instructions

25.

☐ Funds-Out Agreement (Note: EPA Agency Location Code (ALC) - 68010727)

☐ Disbursement Agreement

☐ Repayment Request for repayment of actual costs must be itemized on SF-1080 and submitted to the Financial Management Office, Cincinnati, OH 45268:
☐ Monthly ☐ Quarterly ☐ Upon Completion of Work

☐ Advance Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

☐ Allocation Transfer-Out Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Hdqtrs. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. ☒ Funds-In Agreement

☒ Reimbursement Agreement ☒ Repayment ☐ Advance

☐ Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Resp. Center No.
DE-AI08-96NV11969	33D
Other Agency's Billing Address *(include ALC or Station Symbol Number)* Department of Energy Nevada Operations Office ATTN: Financial Management Division, P.O. Box 98518 Las Vegas, NV 89193-8518	**Other Agency's Billing Instruction and Frequency** ON-LINE PAYMENT AND COLLECTION (OPAC) SY SYSTEM IS USED

Part IV - Acceptance Conditions

EPA IAG Identification Number: RW89937611-01-0

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-In actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address US Environmental Protection Agency Grants Operations Branch B Grants Administration Division 401 M Street, SW (3903F) Washington, DC 20460	30. Organization/Address U.S. ENVIRONMENTAL PROTECTION AGENCY RADIATION SCIENCES LABORATORY P.O. BOX 98517 LAS VEGAS, NV 89193-8517

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	E. RAMONA TROVATO, DIRECTOR, ORIA	

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	W. SCOTT McMORAN, CHIEF GOB B/GAL	

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date
SEE ATTACHED DOE FORM 1270.1	BRADLEY M. BOURN, CONTRACTING OFCR.	

DOELAP

United States Department of Energy
Laboratory Accreditation Program
for Personnel Dosimetry Systems

Certificate of Accreditation

U.S. Environmental Protection Agency

is recognized for demonstrating compliance with DOE Standard for personnel dosimetry systems. Accreditation is granted for the dosimetry systems and radiation components specified on the conditions of accreditation.

November 1, 1994

Effective date

Walter M Loesch

DOE Laboratory Accreditation Program Administrator

CONDITIONS OF DOELAP ACCREDITATION

U. S. Environmental Protection Agency

Environmental Monitoring Systems Laboratory - Las Vegas

Effective until November 1, 1996, the whole body personnel dosimetry systems described below, used at the Environmental Monitoring Systems Laboratory - Las Vegas (USEPA), are granted DOELAP accreditation:

Dosimeter Identification:

Panasonic UD-802AT TLD.

Reader System:

Panasonic Model UD-710A Automatic Reader

DOELAP Categories: Panasonic UD-802

- I. Low-Energy Photons, High Dose Levels
- II. High-Energy Photons, High Dose Levels
- IIIA. Low-Energy Photons, Filtered X-Rays
- IV. High-Energy Photons
- ~~VII~~. Mixture Categories:
  III + IV

Accreditation is for these dosimeters and reader systems only and is contingent upon maintaining dosimetry practices that are consistent with the methodologies used during DOELAP performance testing and the onsite assessment. Re-accreditation of your dosimetry system will be necessary every two years as required by DOE 5480.15 and as discussed in the DOELAP Handbook (DOE/EH-0026).

571951

ORC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

SEP 12 1996

U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division
ATTN: Wayne Marchant
Director
P.O. Box 93478
Las Vegas, Nevada 89193-3478

SUBJECT: RESPONSE TO EXEMPTION REQUEST DATED JULY 3, 1996

Your letter of July 3, 1996, which requested a continuation of the exemption to 10 CFR 20.1501 for your in-house DOELAP dosimetry services, was forwarded to NRC Headquarters for review on July 10, 1996. We received their response on September 9, 1996. On September 11, 1996, this matter was discussed with Paul Weeden, Anita Mullen, and Chris Fontana of your staff. The purpose of this letter is to forward Headquarter's comments and to document the telephone conversation referenced above.

NRC Headquarter's staff indicated that, at the time the original exemption was granted, the NVLAP and DOELAP dosimetry testing protocols were comparable. However, in the interim, the NVLAP program, ANSI N13.11,"Personnel Dosimetry Performance-Criteria for Testing," has been substantially modified with the issuance of the 1993 revision. This standard contains differences from those currently in use by the DOELAP program, DOE/EH-0027. The standards differ in some of the spectra used in the low-energy photon testing categories, in the beta radiations used in the beta and mixed photon-beta categories, in the neutron sources used in the neutron category, and in the absence of the angular response category from the DOELAP standard. In addition, there are differences in the testing acceptance criteria. Requirements for determination of the lower limits of detection for the dosimeters used in testing are also different.

The response from Headquarters also noted that DOE's 10 CFR 835.1(b)(1) exempts from Part 835 "activities that are regulated through a license by the Nuclear Regulatory Commission." It was noted that the use of NVLAP-accredited dosimetry is one such activity.

Their reply further stated that, unless there were strong reasons for continuing the exemption, it should not be renewed. The DOELAP accreditation would be recognized until it expires, and then NVLAP accreditation should have been obtained.

In the telephone conversation on September 11, 1996, Anita Mullen stated that there is an Interagency Agreement with DOE which tasks the EPA Las Vegas with supplying between two and three hundred dosimeters for DOE. This agreement is also the basis for the funding for their dosimetry program. Some dosimeters are for personnel use, while others are for environmental monitoring. The agreement presupposes the use of the existing DOELAP system. There are only an additional 20 to 25 dosimeters which are processed quarterly for the laboratories operating under the NRC license. Anita Mullen also stated that to obtain NVLAP accreditation would be costly. She stated that she could obtain an estimate of the cost.

The licensee representatives indicated that the DOELAP accreditation was more appropriate for their use. They did not believe that the technical differences between the two programs should be issues for their facility. Anita Mullen and Chris Fontana were going to explore this matter further. For example, they indicated that the angular response testing was already being performed, although not required by the DOELAP standard.

It was noted that the current DOELAP accreditation expires in January of 1997.

To allow us to continue consideration of your exemption request, you should submit a description of the reasons it should be continued. This should include a copy of the Interagency Agreement with DOE, an estimate of the financial burden involved in obtaining NVLAP accreditation, and a discussion of why the technical differences between the NVLAP and DOELAP programs are not an issue for your licensed program. Your reply will be forwarded to NRC Headquarters for review.

To continue prompt review of your exemption request, we ask that you submit your response to this letter in duplicate, and refer to Mail Control No. 571951.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Docket: 030-06981
License: 27-05861-02
Control: 571951

bcc:

Sami Sherbini, HQRS
Docket File
WCFO Inspection File
LFDCB, T-9 E10

DOCUMENT NAME: G:\beth\DOELAP

To receive copy of document, indicate in box: "C" = Copy without enclosures "E" = Copy with enclosures "N" = No copy

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09/ 6 /96		09/ /96		09/ /96		09/ /96		09/ /96	

OFFICIAL RECORD COPY

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 4, 1996

MEMORANDUM TO: Frank A. Wenslawski, Chief
Materials Branch, WCFO

FROM: Donald A. Cool, Director
Division of Industrial and
Medical Nuclear Safety, NMSS

SUBJECT: REQUEST BY EPA- LAS VEGAS FOR EXEMPTION FROM 10 CFR 20.1501(c) - NVLAP ACCREDITATION

I am responding to your TAR dated July 10, 1996 (attached). In the request, you noted that the license for the EPA - Las Vegas operation is in timely renewal, and that you recommend that License Condition 25 in the current license be included in the renewed license. Condition 25 gives the licensee an exemption from 10 CFR 20.1501(c), which requires that the thermoluminescent dosimeters (TLD) used by the licensee on their site, for monitoring occupational exposures, be processed by a processor accredited under the National Voluntary Laboratory Accreditation Program (NVLAP). Instead, the processor would be accredited under the corresponding Department of Energy (DOE) program, DOE Laboratory Accreditation Program (DOELAP). This license condition was granted on the basis of guidance from NRC Headquarters dated March 24, 1992.

The rationale for the exemption was that EPA-Las Vegas was, and continues to be, engaged in activities under a DOE contract, and that accreditation under DOELAP would thereby facilitate their operations within the DOE facilities. At the time the exemption was granted, the NVLAP and DOELAP dosimetry testing protocols were comparable, and use of DOELAP in place of NVLAP did not represent a significant deviation from accepted NRC practices. However, in the interim, the testing standard used by the NVLAP program, ANSI N13.11, "Personnel Dosimetry Performance - Criteria for Testing," has been substantially modified with the issuance of the 1993 revision. This standard, currently in use in the NVLAP program, contains significant differences from the previous standard, and therefore also from the standard currently in use by the DOELAP program, DOE/EH-0027. The correspondence between NVLAP and DOELAP is therefore less than it was when the license condition was

Contact: Sami Sherbini, IMOB
(301) 415-7902

first granted. The standards differ in some of the spectra used in the low-energy photon testing categories, in the beta radiations used in the beta and mixed photon-beta categories, in the neutron sources used in the neutron category, as well as in the absence of the angular response category from the DOELAP standard. In addition, there are differences in the testing acceptance criteria between the DOELAP and NVLAP standards. Requirements for determination of the lower limits of detection for the dosimeters used in testing are also different in the two standards.

Based on conversations with the licensee, we understand that the desire to continue the inclusion of Condition 25 in the license is based mainly on historical reasons, namely that the TLD system now in use in accredited under DOELAP, and it is convenient to continue use of such an established system. Removal of this condition from the license would require the licensee to obtain accreditation under NVLAP, a process that could prove costly and time-consuming. However, in view of the differences between the two standards noted above, this is not sufficient reason to grant the exemption. In addition, even though the licensee conducts work at DOE facilities, they may use NVLAP-accredited dosimetry, as provided by DOE's regulations. DOE's 10 CFR 835.1(b)(1) exempts from Part 835 "activities that are regulated through a license by the Nuclear Regulatory Commission." Use of NVLAP-accredited dosimetry is one such activity.

Therefore, unless the licensee provides a sufficiently strong reason for continuing the exemption, we believe that License Condition 25 should no longer be included in the renewed license. Reasons for granting the exemption include the presence of radiation sources in the work environment that are significantly different from those included in the NVLAP testing standard but included in DOELAP, a requirement to be DOELAP accredited, or inordinately high financial burdens involved in obtaining NVLAP accreditation. The licensee should be permitted to continue operation under their current DOELAP accreditation until it expires, and in the meantime prepare for accreditation under NVLAP.

Please call the technical contact if you need further information or clarifications.

Attachment: As stated

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

July 10, 1996

MEMORANDUM TO: Donald A. Cool, Director
Division of Industrial and Medical Nuclear Safety, NMSS

FROM: Frank A. Wenslawski, Chief
Materials Branch

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS
CONTROL 571951

This Technical Assistance Request (TAR) is sent to you to determine whether an exemption from 10 CFR 20.202(c)--now 10 CFR 20.1501(c)--can be continued when the license is renewed (the license is in timely renewal status). License Condition 25. currently allows the licensee to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP). This matter was previously sent to Headquarters in a TAR dated January 23, 1992. In a response dated March 24, 1992, it was stated that Headquarters had reviewed the DOELAP program and had determined that it satisfied the criteria outlined in NVLAP. For this reason, it was recommended that EPA's request be approved.

We recommend that their request for renewal of this exemption be granted. If their request cannot be granted, please specify the reasons.

If further information is required, contact Beth Prange at (510) 975-0250.

Enclosures:

TAR Form dated July 9, 1996
Letter dated July 3, 1996
Handbook for the DOELAP for Personnel Dosimetry Systems
DOE Standard for the Performance Testing of Personnel Dosimetry Systems
Amendment No. 22 to License No. 27-05861-02

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: July 9, 1996

Mail or E-Mail to: Donald A. Cool, Mail Stop: TWFN 8F5 If E-mail, cc: DAC
Division of Industrial and Medical Nuclear Safety, NMSS

From: Frank A. Wenslawski (FAW) Region IV, WCFO
Chief, Materials Branch

Licensee: EPA, Las Vegas License No.: 27-05861-02

Control No. 571951

Letter dated: July 3, 1996

☐ Problem/Issue: The licensee wishes to renew an exemption from 10 CFR 20.202(c)---now 10 CFR 20.1501(c)---to allow them to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

☐ Action Required: Review their request and determine whether the exemption can be continued. If not, specify the reasons.

Recommended Action (with revisions): X Approve

Headquarter Reviewer: (For HQ use)
Regional Reviewer: Beth Prange (BAP1)
Reviewer Code: W1
Reviewer Phone No.: (510)975-0250 FAX No.: (510)975-0381
Request Needed by: 09/09/96

Form TAR-10
9/93

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

OFFICE OF
RESEARCH AND DEVELOPMENT

July 3, 1996

U.S. Nuclear Regulatory Commission-Region IV
Walnut Creek Field Office
Attention: Materials (Licensing) Branch, Beth A. Prange
1450 Maria Lane
Walnut Creek, CA 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981
Control No. 571951

Subject: Exemption to 10 CFR 20.202(c) (now 10 CFR 20.1501)

Dear Ms. Prange:

As you suggested in your letter dated May 28, 1996, and during our conference call yesterday, I am enclosing two copies of DOE/EH-0026 and DOE/EH-0027. Both are current and dated December 1986. In connection with our pending license renewal application, I request continuance of our exemption to 10 CFR 20.1501 for our in-house dosimetry services for our radiation workers.

If you need additional information, please call me at 702-798-2525, or our Radiation Safety Officer, Loyd Carroll, at 702-798-2313.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

2 Enclosures (2 ea)

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (40% Postconsumer)

571951

DOE/EH-0026
Distribution Category: UC-41

HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

**DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems**

Published December 1986

**U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health
Washington, D.C. 20545**

FOREWORD

The program contained in this Handbook provides a significant advance in the field of radiation protection through a structured means for assuring the quality of personnel dosimetry performance. This program culminates an effort initiated by DOE's predecessor in early 1963. Since personnel dosimetry performance is directly related to the assurance of worker safety, it has been of key interest to the Department of Energy (DOE) (and its predecessor agencies). Studies conducted over the past three decades have clearly demonstrated a need for personnel dosimetry performance criteria, related testing programs, and improvements in dosimetry technology. In responding to these needs, the DOE Office of Nuclear Safety (EH) has developed and initiated a DOE Laboratory Accreditation Program (DOELAP) which is intended to improve the quality of personnel dosimetry through (a) performance testing, (b) dosimetry and calibration intercomparisons, and (c) applied research.

In the interest of improving dosimetry technology, the DOE Laboratory Accreditation Program (DOELAP) is also designed to encourage cooperation and technical interchange between DOE laboratories. Dosimetry intercomparison programs have been scheduled which include the use of transport standard instruments, transport standard radioactive sources and special dosimeters. The dosimeters used in the intercomparison program are designed to obtain optimum data on the comparison of dosimetry calibration methodologies and capabilities. This data is used in part to develop enhanced calibration protocols. In the interest of overall calibration update, assistance and guidance for the calibration of personnel dosimeters is available through the DOELAP support laboratories.

To further the efforts in dosimetry upgrade we are also encouraging a closer cooperation and working relationship between the researcher and those involved in performance testing. Feedback to the DOE dosimeter processors on dosimeter performance and applied research efforts will be provided by DOELAP.

The relationship between the DOELAP and the NVLAP (National Voluntary Laboratory Accreditation Program) which services NRC licensees has also been established. The DOE recommended to the Interagency Policy Committee on Personnel Dosimetry, a program, which integrates the DOELAP and NVLAP under the National Dosimetry Accreditation Upgrade Program through an efficient flow of information between the programs. The DOELAP and NVLAP utilize similar methodology. However, the DOELAP is more comprehensive through necessity because of the complexities of the DOE programs to be accredited and the need for more restrictive performance testing.

The DOELAP is basically contained in four documents:

1. "DOE Order 5480 Series,"
2. "Department of Energy Standard for the Performance Testing of Personnel Dosimetry Systems" (provides testing criteria to accredit personnel dosimeters) - DOE/EH-0027,
3. "Handbook for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (provides operating procedures for program), and
4. "Quality Assurance Manual for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems" (applies to the performance testing laboratory only) - DOE/ID-12105.

E. J. Vallario, Group Leader
Health Physics Programs
Office of Nuclear Safety
U.S. Department of Energy

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HANDBOOK FOR THE DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM FOR PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

The Department of Energy (DOE) and its predecessor agencies have been concerned about personnel dosimetry performance since the late 1950s. Studies conducted over the past three decades have clearly demonstrated DOE needs both performance criteria for personnel dosimetry and a testing program to determine the criteria have been met.[1-13]

In 1973, the Conference of Radiation Control Program Directors recommended establishing a program for continually testing personnel dosimetry performance throughout the United States. The Conference appointed a task force with state and federal participants to implement this recommendation. The task force concluded that existing standards were inadequate for the purpose. It asked the Health Physics Society Standards Committee (HPSSC) to develop a new Standard to establish criteria for testing personnel dosimetry performance. In 1975, HPSSC charged a working group with writing such a Standard for the American National Standards Institute as ANSI Standard N13.11.[14]

In 1976, the Conference of Radiation Control Program Directors, the Nuclear Regulatory Commission (NRC), predecessor agencies of DOE, and the National Center for Devices and Radiological Health (NCDRH) jointly sponsored a public meeting. This meeting was held to discuss the problems associated with personnel dosimetry. At that meeting copies of the draft standard *Criteria for Testing Personnel Dosimetry Performance*, which HPSSC had developed, were distributed. Many of those attending the meeting strongly recommended a pilot study be undertaken to evaluate the draft standard. As a result of that recommendation, the University of Michigan conducted three rounds of personnel dosimetry proficiency testing from 1977 to 1982. Upon completion of the University of Michigan studies, the standard was adopted as a Health Physics Society Standard. The Board of Standards Review of ANSI accepted it as a final American National Standard.[14] The National Voluntary Laboratory Accreditation Program (NVLAP) is using it as a basis for an accreditation program for personnel dosimeters.[15]

Independent of the University of Michigan testing program, DOE conducted a program to evaluate ANSI N13.11 for use in its DOE/DOE contractor personnel dosimetry programs. The studies DOE conducted have demonstrated ANSI N13.11 is not adequate for testing the personnel dosimeters used at DOE/DOE contractor facilities.[12] Accordingly, DOE developed a comprehensive Standard for performance testing its personnel dosimetry systems.[16] The Standard is a modification of ANSI N13.11[14] and is based on recommendations made while evaluating the ANSI Standard. Moreover, DOE wanted a testing program that would encourage further research and promote communication among the DOE/DOE contractor organizations. This kind of program would bring about new developments and procedures to be used to improve dosimetry performance. Therefore, DOE decided to establish a dosimetry testing program consistent with its needs. The program is called the DOE Laboratory Accreditation Program (DOELAP). DOE intends to eventually coordinate its testing program with that of NVLAP. Therefore, DOELAP follows NVLAP methods and procedures as much as possible.

Accreditation is the assessment of whether or not a personnel dosimetry system meets specific criteria. The assessment includes dosimeter performance and the associated quality assurance and calibration programs. The accreditation process includes the development of recommendations for any improvements needed to ensure continuing quality. DOELAP's objective is to accredit the personnel dosimetry systems of DOE/DOE contractors, regardless of whether the dosimeter processing is conducted at commercial or in-house facilities. The term "DOE contractor" will refer to the DOE/DOE contractor facility eligible for accreditation. The term "processor" is limited to the facility handling and evaluating the personnel dosimeters.

This handbook describes the procedures for obtaining accreditation. In general, to obtain accreditation, contractors must:

1. Meet the test criteria in the DOE Standard
2. Pass an onsite assessment of the documentation, quality assurance, and technical adequacy associated with personnel dosimetry systems.

A performance testing laboratory determines the ability to meet the test criteria. Members of a team of experts in personnel dosimetry conduct onsite assessments. The Standard is consistent with the current capabilities of dosimetry systems. However, it will be upgraded as improved dosimetry capabilities become available. This particularly applies to beta-particle and neutron dosimetry.

2. SCOPE OF ACCREDITATION PROGRAM

The DOELAP for personnel dosimetry systems applies to the technical aspects of personnel dosimetry systems at DOE/DOE contractor facilities and to the documentation of those aspects. During the accreditation:

1. A performance testing laboratory evaluates the technical performance of dosimetry systems
2. An onsite assessment studies the quality assurance, documentation, and technical adequacy of such systems.

Dosimeter types or models used to determine whole-body and skin dose for personnel are included in the scope of the Accreditation Program. Accreditation currently does not apply to extremity dosimeters, pocket ionization chambers, thermal neutron dosimetry, and high-energy neutron dosimetry. The program scope does not forbid a laboratory to provide additional dosimetry services (i.e., personnel, extremity, environmental, or area monitoring). Nor does it preclude a laboratory from operating research programs to improve the dosimetry services. Calibration services are accessible, for a fee, to laboratories requiring characterization of dosimetry systems in routine use or under development.

The DOELAP allows abbreviated testing for dosimeter types known or suspected to be noncompliant in certain categories. The dosimeter type will be considered adequate or accreditable only if it is used in those environments covered by the categories for which it was successfully tested.

The DOELAP test standard scope is limited. Approximate energy intervals covered are: 15 keV to 2 MeV for photons; above 0.3 MeV for beta particles; and 1 keV to 2 MeV for neutrons. Additional test categories covering other energy ranges are being developed as the need arises and time permits. DOELAP does not currently cover occupational environments containing significant contributions outside these ranges. Processors are not required to test dosimeters used for these environments.

Every two years, each DOE contractor must maintain its accreditation by demonstrating compliance with DOELAP criteria.

3. ADMINISTRATION OF THE PROGRAM

The DOELAP is managed by the DOE Office of Nuclear Safety. The DOE Headquarters (HQ) DOELAP Administrator provides for the overall program management. An Oversight Board technically reviews DOELAP protocol and makes recommendations concerning accreditation. The Oversight Board consists of five DOE/DOE contractor personnel. Each serves a 2-year term. An Appeals Board considers contractor appeals concerning accreditation denial. It consists of six DOE/DOE contractor personnel. The performance evaluation program at the DOE Radiological and Environmental Sciences Laboratory (RESL) at the Idaho National Engineering Laboratory (INEL) coordinates the accreditation process. The Performance Evaluation Program Administrator at RESL is responsible for conducting the performance testing and site assessment programs and for maintaining all documentation associated with DOELAP.

The HQ DOELAP Administrator will periodically request nominations for a pool of technical experts to serve in this accreditation program. The experts are selected by evaluating their professional and academic achievements and their experience in dosimetry. The onsite assessors, members of the Oversight Board, and of the Appeals Board are selected from this pool. Each board will select its own chairman.

4. ACCREDITATION PROCESS

The Performance Evaluation Program Administrator coordinates the accreditation process for personnel dosimetry systems. To obtain accreditation, a DOE contractor must first submit an application through the field office. The contractor must then satisfy both the performance testing and the onsite assessment requirements. The Performance Evaluation Program Administrator prepares an administrative report documenting the test results and recommendations for accreditation. The Oversight Board evaluates the report and the recommendations and, if approved, sends them to the HQ DOELAP Administrator. The HQ DOELAP Administrator makes the final decisions on accreditation and issues the Certificates of Accreditation. A Certificate of Accreditation specifies the model(s) or type(s) of dosimeters accredited for specific radiation categories.

If a dosimetry system, or part of a dosimetry system, is found noncompliant with DOELAP criteria, the contractor and field office prepare a remedial action plan to implement immediately. The plan is sent through the DOE field office to the HQ DOELAP Administrator with a copy to the Performance Evaluation Program Administrator. The contractor and field office may appeal to the Appeals Board at any point in the accreditation process. In the meantime, the dosimetry system may be partially accredited. If the system has demonstrated satisfactory performance in a subset of the DOELAP irradiation categories and if the remedial action plan is initiated, the accreditation process may continue in those categories. When more than one dosimeter design is used to meet the special needs at a laboratory, it is possible for a portion of a dosimetry system to receive final accreditation while the remaining part requires a remedial action plan.

If a DOE contractor uses the services of a commercial processor, both the contractor and processor facilities will be visited. If more than one DOE contractor is using the same commercial processor, only one site visit to the processor may be required. More than one DOE contractor may use performance test data for a commercial processor if each contractor facility uses the identical dosimeter design and if the appropriate test categories are included. Site-specific calibration factors and response algorithms are required if used for routine evaluations. The Performance Evaluation Program Administrator must approve combined evaluations, and the Oversight Board must review them.

The following sections describe the phases of the accreditation process in more detail.

4.1 Application

The contractor initiates the accreditation process by submitting an application form (Appendix A) through the appropriate field office. To expedite the process, a designated representative of the applying laboratory management (e.g., the laboratory's head health physicist) should complete the application as thoroughly as possible and sign it. The designated representative should be familiar with all DOELAP requirements. The representative reviews all documents and acts as liaison between DOE/DOE contractor management and the Performance Evaluation Program Administrator. Other staff members may be designated to perform specific activities (e.g., handling proficiency testing or receiving an assessor). Yet, only one designated individual should be responsible for requesting a change in the scope or nature of the accreditation.

The application requires each applicant to describe the particular processing system employed. The description should include the specific apparatus and protocols used and whether processing is done manually or automatically. It should also identify the equipment and procedures to be used for the appropriate testing categories. The information submitted should describe the system used as thoroughly as possible without divulging proprietary information.

The application is used to:

- Enroll the DOE/DOE contractor facility in the program
- Determine the dosimeter types or models and test categories desired for accreditation
- Gather information about the DOE/DOE contractor's facility and organizational structure for evaluation purposes
- Select assessors with the proper technical background for the onsite visit
- Gather information necessary to prepare for an onsite visit.

The contractor sends the application to the appropriate field office. There, it is reviewed and, if approved, sent to the Performance Evaluation Program Administrator.

4.2 Performance Test

Performance testing is the first requirement of the DOELAP accreditation process. The procedures contained in the DOE Standard are briefly highlighted in this section.

A dosimeter type may be accredited in one or more of the radiation categories shown in Table 1. This table contains the source specification, energies, and dose range for each category. The contractor must specify the exposure categories and the types or models of the dosimeters submitted for accreditation.

The test period is three to six months. The contractor must submit three shipments of dosimeters during this test period to the performance testing laboratory for irradiation. The contractor shall normally submit five dosimeters in each test category with each shipment. The contractor will be required to include a specified number of additional dosimeters of each design in each shipment to be used as controls and when necessary as replacements. The Standard specifies certain cases where 10 dosimeters per category per shipment may be submitted for irradiation. These cases must be coordinated with the DOELAP Performance Evaluation Program Administrator.

The dosimeters are then irradiated and returned to the contractor. The contractor must read each one and determine a dose or dose equivalent. The testing laboratory will identify all dosimeters irradiated in Categories I and II and those irradiated for the neutron tests (Categories VI & VII). Dosimeters irradiated in the mixture categories Categories III, IV, and V and VII (not including neutron irradiations) are not identified by category. In these cases, the processor must determine the dose for each dosimeter without knowing the irradiation category. Pretest calibration exposures for neutron categories are recommended and will be provided upon request. The contractor will identify the neutron field(s) to be used for the performance testing. Besides identifying the dosimeters irradiated by the neutron sources to the contractor, the testing laboratory will provide the ratio of responses of a BF_3 detector in a 9-in.-dia sphere and in a 3-in.-dia sphere covered with 10-mil-thick cadmium. The ratio gives the contractor a relative calibration for albedo dosimeters. This information may be useful to relate the test fields to the neutron fields in the occupational environment.

The radiation sources and geometries are described fully in the Standard. A brief description of them follows:

1. A sealed ^{137}Cs gamma-ray source
2. X-ray machine(s) producing continuous spectra using the techniques of the National Bureau of Standards,[18] and capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV).
3. A sealed $^{90}Sr/^{90}Y$ beta particle source with a 100-mg/cm^2 filter (nominal) to remove the ^{90}Sr component - The residual maximum energy, as defined in the International Standard ISO 6980,[19] shall equal or exceed 1.80 MeV. The in-phantom dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 1.01 ± 0.03. The in-phantom dose rate at 1000 mg/cm^2 shall be less than 1% of the dose rate at 7 mg/cm^2. The measurement specifications take precedence over the irradiation geometry specifications.
4. A sealed ^{204}Tl source filtered by 50 mg/cm^2 (nominal) - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV. The in-phantom dose rate at 20 mg/cm^2 divided by the in-phantom dose rate at . mg/cm^2 shall be 0.80 ± 0.05. The measurement specifications take precedence over the irradiation geometry specifications.
5. A natural or depleted uranium slab - The source protective covering shall be in the range between 3 mg/cm^2 and 7 mg/cm^2 inclusive. The dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 0.58 ± 0.04. The measurement specifications take precedence over the geometry specifications. The dimensions of the source must exceed the dimensions of irradiated dosimeters.
6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[17]

The Standard of performance for DOELAP is based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically

Table 1. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 1. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]		0.05-5 rem	Shallow,
III & V	One energy	0.2-5 rem	Deep
IV & V[a]	from each	0.2-5 rem	
III & VI[h]	category	0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 14.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 17).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[13] A test criterion:

$$| B | + S \leq 0.30^{a} \qquad (1)$$

can be interpreted as providing approximately 70% confidence a dosimeter response would be within 30% of a conventionally true value. For workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence the annual reported dose equivalent would be within 30% of a conventionally true value.

The criterion in Equation (1) is consistent with the recommendations of the National Council on Radiation Protection and Measurement (NCRP), the International Commission on Radiation Units and Measurements (ICRU), and the International Commission on Radiological Protection (ICRP). Reference 16 points out the following caveats:

- The NCRP and ICRU recommend 30% for the accuracy with 95% confidence. To meet these requirements, at least four dosimeters receiving approximately equal doses must be used to determine the annual dose.
- The recommendation by the ICRP of accuracy within a factor of 1.5 at the 95% confidence level is approximately met for each dosimeter (and thus for each worker). However, the uncertainty due to angular response included in the ICRP accuracy recommendations is neglected in the test criteria. The criterion in Equation (1), using quarterly exchange rates to achieve 95% confidence, is the approximate equivalent of reserving up to 20% additional bias for angular response variations.
- The NCRP recommends 20% accuracy at high doses. The ICRU and ICRP favor a special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions are neglected in the test criterion. Examples of such unknowns are the position of dosimeter relative to source distribution or its location on the body of the wearer.

The criterion in Equation (1) was modified to reduce the probability of a failure due to the imprecise delivery of dose equivalent to the test dosimeters and to permit more time for fine adjustments in the mixture categories. The DOELAP Test criterion is:

$$| B | + S - | E | \leq L \qquad (2)$$

where

$L = 0.30$ for Categories I through VI

$L = 0.40$ for Category VII

and E is the estimated fractional uncertainty in the delivered dose or dose equivalent rate. The performance testing laboratory determines the value of E. It will typically be in the range between 1% and 4%.

The test for the low-energy beta source listed in Table 1 does not require using Equation (2) because of the technological and practical limitations of current dosimeter designs. Instead, this less stringent test is used for ^{204}Tl:

$$| B | - | E | \leq 0.40 . \qquad (3)$$

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a. Bias (B) - the average of the performance quotients, P_i, for n dosimeters, for a specific irradiation category and depth.

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1a)$$

where

$$P_i = \frac{(\text{Reported})_i - (\text{Delivered})_i}{(\text{Delivered})_i}$$

Standard Deviation (S) - The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth.

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)^2}{n - 1} \right]^{1/2} \qquad (1b)$$

This criterion was chosen based on the low-energy beta performance of current DOE dosimetry systems, as discussed in the Standard.[16] The ^{204}Tl source is not used in any mixture categories unless requested by a participant. The performance criteria for Category VII and for the ^{204}Tl tests will be upgraded to that of the other categories and sources two years after the effective date of the DOE Order.[20]

The dose interpretation algorithms used for reporting occupational doses should be used for the performance tests, if practical. If changing an algorithm to meet the DOE Standard specifications increases the error of reported occupational doses, that algorithm should not be changed. Using different calibration factors for the tests and for various occupational environments is justified if it results in an improved dose estimation. The contractor must document the relationship between the algorithms used for the test and the reported worker doses. The contractor must also justify the use of environment-dependent factors.

The categories for low-energy photon and beta particles offer a choice of sources. The "A" categories are for general sources, the "B" or "C" categories for specific occupational environments or applications. For example, Category IIIA is for general low-energy photon environments. Category IIIB applies specifically to plutonium environments. Testing in both subgroups of Category III is appropriate for a dosimeter used in both plutonium and nonplutonium environments with significant x-ray fields. Different dose interpretation algorithms may be used for Categories IIIA and IIIB if they are the same ones used to estimate the occupational doses.

The beta particle categories are for general beta environments ($^{90}Sr/^{90}Y$ and ^{204}Tl point sources—Category VA), environments containing uranium sources (slab uranium—Category VB), and environments having predominantly high-energy or low-energy betas (a $^{90}Sr/^{90}Y$ or a ^{204}Tl point source—Category VC). The sources in Category VA have energy spectra suitable for an energy response test for beta fields. According to Reference 19, an energy response test may include ^{147}Pm, ^{204}Tl, and $^{90}Sr/^{90}Y$ sources. These are contained in the ISO series 1 sources, designed for dose rate uniformity over large areas. The Category VB source may be preferable in a dosimetry system designed to monitor uranium fields when a similar source is routinely used for beta dose standardization.

The exposure geometry from contact with a slab produces a different depth dose curve from the curve obtained at a distance from a point source. Present dosimeter designs may require calibration factors for occupational environments that are significantly different from the slab uranium source factors. The contractor is responsible for demonstrating that calibration obtained from the slab uranium source is appropriate. Category VC may be preferable if the occupational environment contains only limited beta energy ranges. The limited range must be identified as being closer to the energy of $^{90}Sr/^{90}Y$ or of ^{204}Tl. The contractor chooses the beta source in Category VC before initiating the test. If more than one of Categories VA, VB, and VC are chosen, the contractor may use different dose-interpretation algorithms when those same algorithms are used for specific occupational environments.

After each shipment of dosimeters is returned, the contractor determines the dose for each dosimeter and reports the doses to the performance testing laboratory. When all three rounds have been completed, the performance testing laboratory mails the results of the proficiency testing to the contractor. If the contractor does not demonstrate satisfactory performance in one or more categories during a test sequence, the laboratory will send the contractor a notice of required retesting with the test results.

For each dosimeter type, the retest sequence is as follows:

1. Categories I and II - When a contractor tests in both high-dose categories and the test result is not satisfactory in one or both, retesting in both is required. When a contractor tests in only one high-dose category and the test result is not satisfactory, retesting in that category is required. Whenever the test result is not satisfactory for a high-dose category, retesting in the corresponding protection level category (III or IV) is also required.
2. Categories III, IV, V, VI, and VII - When a contractor tests in three or fewer protection level categories and the test result is not satisfactory in one of these, the contractor must retest in all of them. A second case occurs when a contractor tests in more than three protection level categories, and the test result is not satisfactory in one of these tests. Then the contractor must retest in that category and in two additional

protection level categories for which their performance was satisfactory. The contractor will not know which two additional categories are chosen. Finally, when performance is not satisfactory in two or more protection level categories, retesting is required in all protection level categories for which accreditation is sought.

4.3 Onsite Assessment

To become accredited, a contractor must demonstrate the ability to conduct a credible personnel dosimetry program. For initial accreditation, an onsite visit is required after the performance testing has been satisfactorily completed. This visit shall assess the quality assurance, documentation, and technical aspects of the personnel dosimetry program. Appendix B contains the assessment criteria. Assessors may use them with considerable latitude according to their experience and as the unique conditions at each processing facility may dictate. The onsite assessment is repeated at least every two years.

Two assessors are assigned to visit each facility. Assignments are based on how well the assessors' individual experience matches the type of processing to be assessed. Assignments also are made to avoid conflicts of interest. The contractor is told of the assignments and has the right to appeal the assignment of an assessor to the Performance Evaluation Program Administrator. If the contractor and the Program Administrator cannot agree on an assessor, they may ask the Appeals Board to resolve the difference. When the assessors have been assigned, the Program Administrator contacts the contractor to arrange a mutually agreeable date for the visit. The field office is notified of the dates of the site visit. The time needed to conduct an onsite visit varies. A two-man team typically requires two to three days.

The assessors:

1. Begin the visit by meeting with the management and the supervisory personnel responsible for the dosimetry activities for which accreditation is being sought. The assessors acquaint management with the assessment process and set the agenda for the visit.
2. Evaluate the contractor's quality assurance system.
3. Select and trace the history of a sample batch of dosimeters from when the dosimeters are received to the time a dose report is issued.
4. Thoroughly review the contractor's performance test results.
5. Review the contractor's quality assurance documentation.
6. Examine technicians' notebooks for records about the selected group of dosimeters.
7. Check dosimeter identification and tracking procedures.
8. Determine if the appropriate environmental conditions are maintained.
9. Examine copies of completed reports.
10. Evaluate documentation.
11. Evaluate technical aspects. These include: personnel training and competency, facilities and equipment, equipment calibration and maintenance, and record-keeping systems.
12. Conduct a close-out meeting with management and supervisory personnel to explain their findings and to clarify the contractor's responsibilities.
13. Leave a copy of their reports with the contractor.
14. Conduct monitoring visits between the biennial assessments.

The following subsections discuss some of these activities. Subsections 4.3.1 through 4.3.3 provide a general overview of the program elements assessors are likely to consider important components of a satisfactory dosimetry program. Subsections 4.3.4 through 4.3.6 discuss the close-out meeting, procedures for correcting deficiencies, and monitoring visits.

4.3.1 Quality Assurance Program. The key to a properly functioning organization is an ongoing quality assurance (QA) program. A QA program is an organization's internal system of procedures and practices to ensure the quality control of its services. A QA manual should document this program. To qualify for accreditation, a contractor must demonstrate its QA program during the onsite visit. Criteria for the QA program are contained in Appendix B.

4.3.2 Documentation. A contractor must have up-to-date documentation thoroughly describing all of its significant procedures and practices. These

written descriptions should contain such items as: (a) personnel requirements and responsibilities, (b) a system for maintaining necessary records, (c) operating procedures, (d) procedures to employ in the event of unusual or nonstandard circumstances, and (e) scheduling. Written descriptions should cover at least these topics:

Personnel

- Organizational chart
- Job/position description for all dosimeter-processing and records-management personnel
- Procedures for training personnel
- Assurance of personnel competency

Equipment

- Processing-equipment inventory, including radiation sources used for calibration
- Practices for processing-equipment calibration, verification, and maintenance
- A test plan (processing protocol) for the conduct of the performance tests for each dosimeter design processed
- Instructions for operating all processing equipment, including instructions for performing operational quality assurance checks

Dosimeters

- Dosimeter models and design specifications
- Acceptance criteria for incoming dosimeter holders and materials
- Procedures for handling and storing sensitive dosimeter components and materials
- Assembly/disassembly techniques for all dosimeter models used
- Procedures for periodic checks of in-service dosimeters
- Identification and tracking of dosimeters
- Procedures for handling and storing in-service dosimeters
- Actions to repair or replace damaged dosimeters

Calibration

- Relationship(s) between dosimeter calibrations and field spectra
- Dosimeter calibration techniques and procedures, including traceability paths

Reporting

- Data handling and reporting
- Actions to be taken when variations in test data indicate a problem.

4.3.3 Technical Adequacy. Contractors must ensure employees do their jobs well by having adequate procedures for training and utilizing employees. Contractors must also provide adequate equipment, facilities, and maintenance procedures.

4.3.3.1 Personnel Training. The contractor must ensure each new staff member is trained for the processing duties assigned. The competency of staff members should be verified and documented annually. In addition, all staff members should be retrained when processing equipment and protocols are changed or when the staff members are assigned new responsibilities.

Each staff member must receive (or have had) training for the assigned duties through on-the-job training, formal classroom sessions, or a technician certification program. This training should be documented in the personnel file.

4.3.3.2 Personnel Competency. The technical director of the personnel dosimetry program should be a professional experienced in applied radiation dosimetry. He/she should be knowledgeable in the design and operation of the dosimetry system(s) currently utilized. This individual should have the technical competence to establish any required dosimetry programs. He/she should also have the supervisory capability to direct the work of professionals and technicians in the dosimetry area. The technical director may be responsible for the quality assurance program. If not, responsibility is assigned to another individual. This person should have knowledge and experience in quality assurance. He/she will communicate directly to the technical director and other organizational management. If a second individual has responsibility for the QA program, the description for that position should be included in the organization description. There should be enough trained staff members to provide program continuity.

In addition to providing for staff training, the technical director must annually evaluate the competency of each staff member authorized to perform

dosimeter evaluations. These staff evaluations should be available for review.

The DOELAP Performance Evaluation Program Administrator must be informed of any organizational or personnel changes that could affect the performance of the contractor's dosimetry program. Changes such as technical supervision or responsibility for quality assurance program should be reported to this Administrator within 60 calendar days of the change.

4.3.3.3 Facilities and Equipment. The contractor or dosimeter processor must have facilities and equipment adequate to perform the type(s) of processing for which it claims capability. Proper shielding should be provided to protect areas from unwanted radiation, and environmental controls should be maintained. The equipment should include adequate processing equipment and radiation sources. If properly calibrated (NBS-traceable) laboratory-standard equipment for determining dose equivalent is not available, the contractor should have access to the services of a competent calibration laboratory.

Adequate backup equipment or systems for key processing steps should be available for use in the event the primary systems fail. The backup system could be arranging for the services of another DOE-accredited contractor on an emergency basis.

4.3.3.4 Equipment Maintenance and Calibration. The contractor must maintain a preventive maintenance program for equipment used to process dosimeters and to perform quality control checks. When equipment—used for measurement, dosimeter processing, or quality control—is inherently subject to change due to use or the passage of time, it must be calibrated periodically. Calibration is comparing the equipment with a reference standard. This comparison determines the performance of a measuring instrument or the output of a radiation source with sufficient accuracy.

The proper performance of the dosimetry processing system must be verified periodically. Dosimeters irradiated in well-characterized radiation fields are used for this purpose.

Either the contractor or an external calibration service should calibrate equipment or the dosimetry system and characterize radiation fields. All calibrations and characterizations must be performed using reference standards traceable to NBS national standards[18] or to standards maintained by an equivalent foreign national standards authority. Being traceable means being able to show that appropriate documented actions were taken to compare (either directly or indirectly) a reference standard with a national standard.

The transfer standards used and the environmental conditions at the time of calibration must be documented for all calibrations. Calibration records must be made available for inspection during the assessors' onsite visit. The traceability of the reference standards used are verified at that time.

4.3.3.5 Recordkeeping. The contractor must maintain functional records on the dosimetry system. This means the records should be easily accessible, in some logical order, and complete. Records covering the following items are required and are reviewed during the onsite visit:

- Staff training dates and results
- Staff competency review
- Processing-equipment calibration and maintenance
- Data used to develop dosimeter processing algorithms
- Results of inspection of incoming dosimeter materials
- Logs of processing activities
- Results of internal and external equipment checks, measurement quality assurance programs, audits, etc.
- Performance test data and reports
- Tracking and logging dosimeters.

Processing-equipment calibration (or verification) records should include the following: equipment name or description; model, style, or serial number; manufacturer; notation of all equipment variables requiring calibration or verification; the range of calibration/verification; the resolution of the instrument and its allowable error; calibration or verification date and schedule; date and result of last calibration; identity of the laboratory individual or external service responsible for calibration; source of reference standard and traceability.

Dosimeter-tracking and -logging records should trace the movement of each dosimeter through the processing facility, from its receipt through all the tests performed to the final report.

The final dose report the contractor developed for the permanent record should include or reference the location of the following:

- Name and address of contractor

- Pertinent dates and identification of dosimeter, including contractor and corresponding processor identification codes
- Description and identification of the dosimeter and/or elements
- An explanation of any deviation from the protocol routinely used in processing dosimeters that may affect the reported dose (e.g., mishandling of background control dosimeters)
- Identification of anomalies
- Signature of or a reference to the person having technical responsibility
- All additional items identified in the contractor's test plan.

4.3.4 Close-Out Meeting. At the conclusion of the visit, the assessors will discuss their observations with appropriate members of management and identify any findings or deficiencies. A written summary of any deficiencies discussed is left with the contractor's authorized representative. The assessors forward the assessment forms and the written summary to the DOELAP Performance Evaluation Program Administrator for use in the technical evaluation. The contractor is requested to forward within 30 days a written plan for resolving identified deficiencies. This plan should be sent through the field office to the Performance Evaluation Program Administrator.

4.3.5 Deficiencies. Deficiencies identified during the initial onsite visit may require some time to correct. These corrections must be completed before accreditation is granted. Deficiencies noted during subsequent biennial onsite assessments of an accredited contractor should be corrected within 60 days of the close-out meeting. If a contractor disagrees with a part of the assessors' findings, the contractor may request that the Performance Evaluation Program Administrator review and reverse the findings in question. A further appeal may be directed in writing to the Appeals Board if the assessors' findings are upheld. When out-of-calibration apparatus is cited, the apparatus should not be used until corrective action has been completed. Any deficiencies noted for corrective action are reviewed during subsequent onsite visits and technical evaluations.

4.3.6 Monitoring Visits. In addition to regularly scheduled onsite assessments, assessors may be assigned to make monitoring visits at any time during the two-year accreditation period. Monitoring visits may occur for cause or on a random basis. These visits may serve to verify reported changes in the contractor's processing facilities and/or operations. The visits may also explore possible reasons for poor performance in proficiency testing. The scope of a monitoring visit may range from checking a few designated items to making a complete review.

4.4 Granting Accreditation

When the technical evaluation has been completed or at the end of the accreditation period, the Performance Evaluation Program Administrator prepares an administrative report and recommendation for the DOE Headquarters DOELAP Administrator and the Oversight Board. The Board evaluates the report and recommendation and proposes one of two options:

- **Accreditation** - The HQ DOELAP Administrator completes the accreditation process by issuing a certificate of accreditation to the contractor.
- **Remedial Action Required** - The contractor is notified that remedial action is required and of the reason(s) for the remedial action. The contractor must immediately identify and implement a remedial action plan within 45 days of receiving the notification. This plan is sent to the HQ DOELAP Administrator through the DOE field office with a copy to the Performance Evaluation Program Administrator. A contractor may request an Appeals Board review.

Dosimetry systems may be partially accredited if a system is demonstrated to be satisfactory in a particular subset of the DOELAP irradiation categories. If a system has not satisfactorily demonstrated compliance with the test criterion in a particular subset of categories and if a remedial action plan is initiated, the accreditation process may continue in all other categories.

The contractor has the responsibility to inform the Performance Evaluation Program Administrator whenever any changes are made in dosimeters or processing techniques. The contractor must provide evidence supporting a conclusion that the system is technically equivalent to the accredited system. The Performance Evaluation Program Administrator with the Oversight Board's approval makes a determination of technical equivalence. If they decide the

changed dosimeters or techniques are not technically equivalent, the accreditation does not cover the dosimeters or techniques. They must be fully evaluated and/or demonstrate a satisfactory dosimeter performance in accordance with DOELAP requirements before they are covered.

If a change in the type or quality of radiation fields occurs, or is anticipated, the contractor shall inform the Performance Evaluation Program Administrator. The contractor shall also justify either that the existing accreditation is adequate, or that additional accreditation testing is required. The Performance Evaluation Program Administrator will recommend approval or disapproval. The justification with the recommendation is forwarded to the Oversight Board for action. The contractor may request a review of the results by the Appeals Board. If the current dosimetry system is not adequate, the contractor may: (a) apply to accredit either the current system, a new system, or a supplemental system including the new radiation field(s), or (b) obtain dosimetry services from a DOE contractor currently accredited for the radiation field(s) involved.

5. EXCEPTIONS

DOELAP excepts some B-Clause contractors from these requirements. These B-Clause contractors do not perform in-house dosimetry and do not routinely report significant doses received by personnel (e.g., small university contracts). In these cases, the B-Clause contractor may choose to obtain accreditation from either DOELAP or NVLAP. Field offices may apply for additional exceptions to the HQ DOELAP Administrator.

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APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

APPENDIX A

DEPARTMENT OF ENERGY
APPLICATION FOR ACCREDITATION IN PERSONNEL DOSIMETRY

1. DOE site or facility _____

2. DOE Field Office _____

3. Other DOE facilities using your personnel dosimetry services (specify dosimeter designs and applicable categories required). _____

_____

_____

4. Vendor identification, if outside vendor used:

_____

_____

_____

5. Name of authorized representative of management for DOELAP accreditation

Name _____

Title _____

Department _____

Contractor _____

Address _____
Street or P.O. Box City State Zip Code

Telephone _____

6. List all dosimeters, by name and model number, for which accreditation is sought and place an (x) under each dosimeter listed, opposite the appropriate category (see DOELAP Handbook and DOE Standard for a detailed explanation of each category).

Category	Dosimeter Designation
I. Low-Energy Photon[a] (High Dose)	
II. High-Energy Photon[b] (High Dose)	
IIIA. Low-Energy Photon	
IIIB. Low-Energy Photon (Plutonium)	
IV. High-Energy Photon	
VA. Beta	
VB. Beta (Uranium)	
VC. Beta (Special)[c]	
VI. Neutron[d]	

a. Automatically entered if entered in Category IIIA or IIIB.

b. Automatically entered if entered in Category IV.

c. Please specify whether a high energy beta source ($^{90}Sr/^{90}Y$) or a low energy beta source (^{204}Tl) more nearly approximates the beta spectra of your facility.

d. Please specify one or both of the neutron sources. Use only the source(s) that more closely represent the energy spectra found in the occupational environments covered by your service. If the energy spectra vary significantly, both sources may be necessary.

NOTE: If a dosimeter is entered in two or more single categories (III-VI), it is automatically entered into all of the appropriate mixture categories (VII). A combination dosimeter with physically separate parts should be listed as one dosimeter. A separate neutron dosimeter should be considered part of a general beta-gamma-neutron dosimeter and submitted together with the beta-gamma dosimeter to the neutron/photon mixture categories. The Performance Evaluation Program Administrator will inform you of the required number of dosimeters to be submitted for each of the three irradiation periods.

7. Which of the dosimeters listed in the table above are currently in use? Planned for future use? Under study? (No additional information is required for dosimeters under study.)

8. For each dosimeter listed in the preceding table, describe important design features, including: type of dosimeter material, type of badge or dosimeter holder used, dosimeter placement inside the holder, and type and arrangement of absorbers. Diagrams are helpful. (Proprietary information should not be included.)

9. For each dosimetry system listed in the table, attach a short statement to justify not seeking accreditation in any of the listed categories.

10. For each dosimeter, state whether it is processed in-house, in a commercial laboratory, or in another government facility.

11. Describe in-house dosimeter processing, including readout apparatus and procedures and protocols for the handling, storage, and preparation of dosimeters. Indicate whether processing is manual or automatic. Indicate procedures that may differ for different categories.

12. If an angular dependence study of dosimeter performance and a determination of the lower limit of detectability have been performed, results should be included with this application. If not, results will be required prior to the granting of accreditation (see DOE Standard for the Performance Testing of Personnel Dosimetry Systems).

13. If field calibrations of dosimeters are used to determine occupational exposures, the dosimeter calibration documentation for each field type should be included with this application.

I hereby authorize this application and attest that all statements made are true, complete, and correct to the best of my knowledge and belief and are made in good faith.

Authorized Representative:

Printed Name _____

Signature _____

Title _____

Date _____

By authorizing this application you affirm that you are aware that if accreditation is granted to your organization, the accreditation applies to dosimetry processing services using the specific dosimeter models/types in the categories requested and using the processing techniques that were used to demonstrate satisfactory performance in accordance with the DOE Standard. You will be expected to use the same dosimeter(s) and techniques in the normal processing activities you perform.

If any changes are made or deviations occur in these dosimeters or techniques, it will be the responsibility of your organization to provide evidence that such changes lead to results that are technically equivalent to the accredited processing activities. Determination of technical equivalence will be made by the DOE Oversight Board.

If the changes or deviations to the dosimeters or processing techniques are not considered to provide results that are technically equivalent, the new dosimeters and/or techniques will not be covered by the accreditation until they have been fully evaluated and/or their performance has been demonstrated in accordance with the DOE Standard.

In authorizing this application you declare that you commit the applicant contractor to:

- Be examined and audited, initially and on a continuing basis during the accreditation period
- Permit the onsite assessors to review and examine records or other documents required by the DOELAP Handbook
- Maintain compliance with applicable handbook criteria
- Participate in proficiency testing programs that may be required for maintaining accreditation.
  Field Office Review: (to be completed before application is submitted)

Printed Name _____

Signature_____

Title_____

Date_____

APPENDIX B

CRITERIA FOR ONSITE ASSESSMENT

APPENDIX B

CRITERIA FOR ONSITE ASSESSMENT

The site assessors are given considerable latitude in evaluating a contractor's personnel dosimetry program. To help each contractor receive a fair assessment, the assessors are provided with this list of criteria covering the main points of a good program.

General

The contractor shall have the latest versions of the processing protocols, dosimeter specifications, quality assurance manual, and other related documents (equipment manufacturer instructions, etc.) available at the facility. The latest version of these documents must be used in conducting all routine processing.

Personnel

1. The functional organization must be consistent with the current organizational chart for the personnel dosimetry program.
2. The qualifications of the individual who has technical responsibility for the personnel dosimetry program must be consistent with the position description.
3. The individual who has technical responsibility must generally exhibit adequate technical knowledge and management control for personnel dosimetry.
4. The individual who has technical responsibility must ensure all dosimetry data are approved.
5. The qualifications of the individual responsible for personnel dosimetry quality assurance (QA) must be consistent with the position description.
6. The responsibility for maintaining and revising the QA manual must be clearly assigned.
7. All personnel dosimetry program staff members must be familiar with and implement the documented quality control program.
8. Communication between technical and supervisory staff members must be adequate.
9. An independent organizational relationship must exist between dosimeter processing and other contractor activities.
10. A designated individual must exercise the authority to assign processing tasks and to ensure timely dosimeter processing.
11. The responsibility for major equipment maintenance, calibration, and servicing major equipment must be clearly assigned.
12. Assigned staff members must be knowledgeable about dosimeter processing equipment and competent in performing assigned processing tasks.
13. The QA manual must describe practices for ensuring staff member competency.
14. The QA manual must describe the training program to prepare staff members to conduct processing protocols.
15. The QA manual must have provisions for retraining assigned staff members when protocols are revised.
16. The competency of staff members should be verified annually, through one or both of these methods:
    - Observation of the conduct of processing protocols by technically qualified individuals
    - Written examination based on the processing protocols.
17. A record of the dates and findings of competency reviews must be available for review.
18. Specialized skills required to conduct all processing protocols must be documented. The training program for individuals who conduct the protocols must include these skills. In addition, the training must include:
    - A period of close supervision until competency is demonstrated
    - A mechanism to evaluate and inform staff members of the adequacy of their performance in conducting assigned processing protocols
    - A mechanism to retrain periodically and to correct any deficiencies in performance between the retrainings.
19. Agreement between assigned processing responsibilities and the technical areas

addressed in the training program must be apparent.

20. A record of training courses completed by each staff member must be available for review.

Equipment and Facilities

1. A list and description of the facilities and equipment used in all the processing protocols for which accreditation is requested must be available in the laboratory. The list allows the facilities and equipment to be correlated with calibration records.
2. Dosimetry readout equipment appropriate for the dosimetry system must be available.
3. When an annealing oven or furnace is necessary, it must be reserved strictly for dosimeter annealing.
4. There must be a method for securing and maintaining the resources required for the processing activities for which accreditation is requested.
5. Procedures should be established to bring backup equipment into routine service, repair equipment on a rapid-response basis, and/or use the services of another DOELAP-accredited contractor. Such procedures ensure continuity of service when personnel or dosimetry systems fail to perform within the control limits.
6. Dosimetry processing equipment must be identified well enough to permit correlation with calibration records.
7. Adequate controls must be in place to ensure equipment performance at the levels of precision and accuracy the contractor defined in each processing protocol. The operating procedures to be implemented when the equipment fails to meet these criteria must be documented.
8. To help evaluate the stability of equipment performance, records of preventive maintenance and repairs must be available for each piece of processing equipment.
9. Service contracts or an in-house capability to maintain equipment and stock parts must be adequate to ensure continuity of equipment operation.
10. Environmental parameters in the processing facility, including background radiation, must be measured and recorded.
11. Calibration and verification records for major equipment used in dosimetry processing must include
    - Equipment name or description
    - Manufacturer's name
    - Model, style, serial number, or other identifying mark
    - Identification of all equipment variables requiring calibration or verification
    - Range of dose measurements for calibrations
    - Allowable error (taking into consideration instrument tolerance) to coincide with the requirements of each processing protocol
    - Schedule for periodic calibrations, including calibration/verification date
    - Date and result of last calibration/verification, including assessed uncertainty of measurement
    - Identification of staff member or position responsible for equipment calibration, or identity of external service performing calibration
    - Identity of reference standard and how the individual dosimetry data relate to national standards or to nationally accepted measurement systems.
12. The calibration of equipment must be verified at regular intervals. These intervals are determined by equipment type, manufacturing specifications, accumulated stability data, or some other reasonable plan. In all cases, the processor must demonstrate the reliability of the measurements performed.
13. Duties are assigned for all processing equipment maintenance and for routinely verifying all equipment is in proper working order.

Quality Assurance

1. Technicians must be familiar with and implement the documented quality control program.
2. The quality control program must be organized to assess the variability of test results among staff members.
3. The supervisor must examine audit results. Action must be taken to correct any deficiencies.
4. Records of the laboratory's participation in intercomparison programs or external measurement assurance programs must be consistent with practices defined in the QA manual.

5. If processing is conducted in multiple locations within the processor's facility, the processor must perform comparative tests to assess the consistency of dosimetry data.
6. The documented QA system must clearly describe records kept and practices followed. These records and practices must cover the process from the point of dosimeter receipt through to the final delivery of data to the user.
7. Records of any deviation from the use of documented processing procedures, equipment, or facilities must be kept to show no degradation of performance occurred.
8. The QA program must incorporate external checks, including:
   - Processing controls (e.g., light source readings, microprocessor controls)
   - Blind-audit dosimeters
   - Unexposed dosimeters.
9. A comprehensive record of processing activities (i.e., a dated log) must be maintained. This record must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.

Dosimeters

General Criteria

1. Practices for receiving, handling, and storing dosimeters must be consistent with provisions in the QA manual.
2. A positive system for identifying and tracking all dosimeters must be in use.
3. A satisfactory acceptance criterion for all dosimetry material must be established. The criteria must be documented in the QA manual.
4. Sufficient information must be contained in the dosimeter identification code to allow correlation with the record system used in processing.
5. The dosimetry system documentation must include a design specification. The specification must show the minimum and maximum exposure level the dosimeter can record during routine processing.
6. A procedure for checking the proper assembly of dosimeter cards and/or film packets must be documented.
7. Documented procedures must be used to verify:
   - Filter materials are consistent with the dosimeter design
   - Filters are properly placed in dosimeters.
8. A procedure must be established to verify dosimeter holders meet required specifications.
9. The QA manual must document procedures for handling dosimeters before they are issued.
10. Dosimeters placed in service must be checked according to a defined schedule or frequency to ensure all necessary components are in place.
11. A screening procedure must be used to ensure that dosimetry materials (sensitive elements) are consistent with the dosimeter design. The procedure must include phosphor type and sensitivity.
12. The identification system must be adequate to ensure the correct identification of both demountable (nonfixed) and fixed thermoluminescent (TL) elements. The system must also identify the association of each TL element with a position or filter in the dosimeter.
13. The same dosimeter type or model and sensitive elements used during proficiency testing must be used to assess occupational exposures.
14. Information available concerning processed dosimeters should include:
   - Radiation type
   - Dose definition (terminology)
   - Responsibility for handling the dose of record
   - Calibration procedures used in dose determination
   - Quality control
   - Special processing procedures to be used as part of the dosimetry service
   - Directions for handling and using background control dosimeters
   - Identifying anomalies noted during processing.
15. A person must be assigned responsibility for the receipt of in-service and background control dosimeters. There must also be a proced re to cover this. The procedure must include:
   - The individual dosimeter identification, the dosimeter type, and the appropriate processing protocol to be followed
   - Identifying and coding internal and external control dosimeters
   - A mechanism for tracking an individual dosimeter and/or sensitive element through the processing cycle

- A mechanism for identifying dosimeters that have not been returned by clients for processing
- A method for screening dosimeters or TL elements for significant contamination prior to readout
- A method for identifying mishandled background control dosimeters.

16. The location of dosimeters within the laboratory must be documented.
17. Environmental parameters, including background radiation, must be monitored in dosimeter storage areas to ensure adequate storage conditions.

Thermoluminescence Dosimeters (TLDs)

1. Equipment for reading out and annealing TL elements must be appropriate for the system.
2. A written procedure must exist and responsibility must be designated for establishing and checking appropriate instrumentation operating conditions. This check may include the following:
   - Reproducible positioning of the TL element in the reader
   - Stabilization against voltage change or drift in dark current when applicable
   - Reproducible heating cycle that ensures readout of a consistent fraction of relevant stored energy
   - Glow curve output
   - Inert-gas purging
   - Digital readout.
3. A method for removing sensitive elements from the dosimeter case must be documented and implemented. The method must preclude losing information from the sensitive element.
4. The operation and stability of TLD readers must be checked at least daily using preexposed dosimeters or light sources. Records must indicate that no dose measurements are made until equipment conditions have stabilized.
5. Sufficient measurements must have been made to establish the relationship between the TL emission-dose characteristics and the conversion factor. The conversion factor is used to convert instrument reading to dose equivalent.
6. Technicians must understand operating conditions and critical functions of TLD processing equipment, including:
   - Heating/temperature cycle
   - Inert-gas purging
   - Annealing cycle
   - Recognition and resolution of equipment failure.
7. Procedures for loading and unloading the TL reader must be implemented as documented.
8. The processing protocol must include reviewing selected dosimetry data during the readout cycle.
9. Before they are issued, TLDs or phosphors must be subject to an adequate annealing cycle. The annealing cycle must be reproducible regarding time, temperature, cooling rate, humidity, and light.
10. Background readings must be checked according to an established procedure before TLDs are issued.
11. Precautions must be taken to minimize the exposure of light-sensitive TL materials to light.
12. Precautions must be taken to avoid the contamination of TL elements (e.g., by chalk, dust, grease, or any radioactive material).
13. Loading sensitive elements must be carried out in a well-defined order. Loading procedures must prevent confusion in handling visually-similar elements of different TL materials and contamination of TL material in powder form.
14. To prevent damage or unknown exposure during transit, TLDs must be suitably packaged for issue to users.
15. TL material fading under normal conditions must be documented and accounted for over the period of intended use.
16. The TL material for each dosimeter type or model must be capable of withstanding heat treatment required in the dosimetry process.

Film Dosimeters

1. An acceptance procedure must be in place to verify film as received meets the manufacturer's specifications. It must further verify the film's expiration date is beyond the anticipated time of use and processing.
2. Equipment, facilities, and materials must be adequate to support the film processing operations for which accreditation has been requested.
3. Film-processing darkroom(s) must be temperature-controlled and have properly installed safelights. They must either use incandescent lights or be able to demonstrate nonincandescent lights do not affect the dosimeter results.

4. Safelights used in darkrooms must be tested at prescribed intervals. Testing shall measure the fog level of exposed films. Exposure shall be at the normal working distance from the safelights for a period comparable to the maximum processing time.
5. Precautions must be taken to prevent accidentally exposing the films to light while they are being processed.
6. Processing chemicals must be dated and properly stored. A procedure must exist for their disposal when their shelf life expires.
7. Tanks and equipment that hold or are exposed to processing solutions must be chemically inert.
8. The equipment must be capable of measuring film densities equivalent to an optical density of 0.01 to 5. Resolution shall be ±10% or ±0.01 density units, whichever is greater, and the equipment must be adequate to support the workload.
9. Records must demonstrate the accuracy and reliability of all instruments used to determine the gross density of specimen and control films.
   - Densitometer performance must be checked for consistency before use.
   - Densitometers must be calibrated at the most frequent of these three intervals:
     - As the manufacturer recommends
     - Biannually
     - As directed in the processing protocol.
10. Films must be removed in the darkroom and loaded in identifiable order in film racks for processing.
11. Through quality control films, the dose density characteristics of each film emulsion batch must be established. A known relationship with the master algorithm for the dosimeter model must also be established.
12. Quality control films of the same emulsion lot must be included in each processed batch. The quality control films should be exposed to known doses that adequately check the response curve of the dosimeter type. They must be positioned at the beginning and end of each processing batch and at intervals as defined in the processing protocol.
13. At least two unexposed films of the same emulsion lot must be included in each processed batch.
14. Processing control films must be verified as meeting control limits before routine processing activities are initiated.
15. As a minimum, the contractor must follow the film manufacturer's recommendations when adopting chemistry and processing conditions in the processing protocols.
16. Before it is issued, film must be stored unopened. The storage location must be cool, dry, free from chemical vapors or other deleterious agents, and have low background radiation.
17. Film must be current. It must be stored so as to reduce buildup of density due to natural background radiation and/or deterioration with age.
18. Before film is issued, its emulsion lot number must be noted and each lot must be tested. Testing shall check that the fog level, dose density, and spectral characteristics are satisfactory.
19. To prevent damage or unknown exposure during transit, film dosimeters must be suitably packaged for issue to users.
20. Records must show that temperatures and times for development, stop bath, fixing, washing, and drying are reproducible and consistent with processing protocols.
21. Developer/fixer solutions must be kept covered to reduce oxidation and exclude contamination.
22. During development, the developing solution must be agitated to provide for the uniform development of all film.
23. Procedures must be documented and followed to allow the appropriate time lapse between preparing developer and fixer solutions and using them. They must also document and follow the time lapse for discarding or replenishing these solutions according to how long they are used or how many films are processed.
24. If a stop bath is used, procedures must be documented and followed for using and renewing it.
25. Fixing procedures must be documented. They shall be implemented according to the manufacturer's recommendations.
26. Washing procedures after fixing must be as documented.
27. The temperature difference in adjacent processing solutions must not exceed 3°C.
28. Records must indicate the apparatus used to dry film does not exceed the appropriate drying temperatures. Drying temperatures must be documented in the processing protocol.

29. After processing, films must be stored so they may be retrieved without damage to the emulsion.
30. Films must be examined for nonuniform blackening. A special measurement procedure must be defined for those showing significant nonuniform blackening.
31. All measurements made must be recorded with film identification codes.
32. Track detectors must be evaluated using optical or counting equipment appropriate for the anticipated macro- or microscopic track dimension.

Calibration

1. Calibration and verification practices for dosimetry systems must be outlined in the QA manual. The manual must identify the calibration services, reference materials, and measurement assurance programs used.
2. Dosimetry systems must be calibrated to known doses from radioactive sources or radiation-generating machines. The calibration facility radiation fields must be measured with calibrated instruments. Instrument calibrations must be traceable to national standards or based on the measurement of activity of a source. In the latter case, the source must be traceable to primary radiation standards. Care must be taken to maintain a standard source geometry.
3. Calibration protocols used must be appropriate for the sources of radiation at the facility and the potential exposure levels.
4. The energy response of each type or model of dosimeter must be characterized by calibrating each model for all appropriate radiation categories. The dosimeter response must be determined over the exposure range for which it is to be used.

Processing

1. The processing protocol must be documented in sufficient detail that it can be followed by a competent technician.
2. All processing personnel must adhere to processing procedures defined in processing protocols.
3. A comprehensive record of processing activities (i.e., a dated log) must be maintained. The log must contain sufficient identification to allow correlation with calibration/verification and control system records. This record must be available for inspection in the processor's facility.
4. When any deviation from using documented processing procedures, equipment, or facilities occurs, records must show performance remained satisfactory during the period in which the deviation occurred.
5. The individual technically responsible for dosimetry processing or his/her assigned representative must give final approval of dosimetry data. This person must also make decisions regarding questionable data.
6. The algorithm must be satisfactorily documented to indicate its validity for dose interpretation. Documentation must indicate:
   - The algorithm was created and tested using fundamental data that are retrievable.
   - The uncertainty analysis of the algorithm characterizes the precision and accuracy of the dose interpretation to the dosimeter.
   - Process controls were considered and documented when the algorithm was developed.
   - The attributes and limitations of the algorithm are documented.
7. Computational models or algorithms for calculating dose from raw data must be adequate for the processor's dosimetry system.
8. All processing protocols must be audited to ensure no degradation of performance occurs.
9. Each processing protocol must provide for interspersing quality control dosimeters. These dosimeters must have a predetermined relationship to the primary calibration dosimeters as follows:
   - Suitable sources must be used to irradiate the quality control dosimeters.
   - Records must indicate good reproducibility for the irradiation method.
   - Evaluation of the quality control data must be outside the control of the processing technician.
   - The contractor must have determined how frequently blank and quality control dosimeters shall be used. This determination must be based upon the total number of dosimeters processed, equipment stability, the type of quality control checks used, or other suitable means.
10. The dose of quality control dosimeters must be determined either from measurements using a transfer-standard quality instrument or by

calibration from a source of known activity. Instrument calibration and the activity of the source must be directly traceable to primary standards.

11. A procedure must exist for a detailed review of data produced between the last successful quality control dosimeter and the first quality control dosimeter failing to meet control limits.
12. Dose measurements must be identified and recorded at the time of measurement.
13. The useful dose range for the dosimetry system must be established and documented in each radiation category of interest.
14. Control limits to accept dose measurement data from in-service dosimeters must be defined and implemented.
15. The technical director or a designee must review dosimeter data for anomalies before reporting the dose.

Reports

1. The QA manual must outline practices for handling and resolving contested dosimetry data and test reports.
2. The dose report must include:
   - Name and address of processor, if different from contractor
   - Name of contractor
   - Pertinent dates and the identification of dosimeters, including processor and contractor identification codes, if appropriate
   - An explanation of any deviation from routine processing procedures if the deviation could affect the reported dose
   - The signature of or a reference to the person having technical responsibility.

Testing

1. Protocols for proficiency testing in accordance with the DOE Standard must be defined. They must be consistent with routine processing procedures.
2. A written test plan for each radiation category for which accreditation is sought must be available to the processing staff.

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DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

DOE Laboratory Accreditation Program
for Personnel Dosimetry Systems

Published December 1986

U.S. Department of Energy
Assistant Secretary for Environment, Safety, and Health
Washington, D.C. 20545

FOREWORD

This standard is intended to be used in the Department of Energy Laboratory Accreditation Program (DOELAP) for personnel dosimetry systems. It is based on the American National Standards Institute's (ANSI) *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11-1983,[1] recommendations made to DOE in *Guidelines for the Calibration of Personnel Dosimeters*, Pacific Northwest Laboratory (PNL)-4515[2] and comments received during peer review by DOE and DOE contractor personnel. The recommendations contained in PNL-4515 were based on an evaluation of ANSI N13.11 conducted for the Office of Nuclear Safety, DOE, by PNL.[3] Parts of ANSI N13.11 that did not require modification were used essentially intact in this standard to maintain consistency with nationally recognized standards.

Modifications to this standard have resulted from several DOE/DOE contractor reviews and a pilot testing session. An initial peer review by selected DOE and DOE contractor representatives on technical content was conducted in 1983. A review by DOE field offices, program offices, and contractors was conducted in mid-1984. A pilot performance testing session sponsored by the Office of Nuclear Safety was conducted in early 1985 by the Radiological and Environmental Sciences Laboratory, Idaho Falls.[4] Results of the pilot test were reviewed in late 1985 by a DOE and DOE contractor committee.

The DOE Laboratory Accreditation Program provides a structured means for assuring the quality of personnel dosimetry performance. The program was initiated and developed by the DOE Office of Nuclear Safety (Environment, Safety and Health) to improve the quality of personnel dosimetry through (1) performance testing, (2) dosimetry and calibration intercomparisons, and (3) applied research.

Participation in the program is required of all DOE and DOE contractor dosimetry programs (DOE Order 5480 Series). Further information with respect to the requirements and administration of DOELAP program is provided in the "Handbook for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" and the "Quality Assurance Manual for the DOE Laboratory Accreditation Program for Personnel Dosimetry Systems" (applicable to the Performance Test Laboratory only).

Edward J. Vallario, Acting Director
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DEPARTMENT OF ENERGY STANDARD FOR THE PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SYSTEMS

1. INTRODUCTION

1.1 Purpose

This standard defines a set of reference performance tests to help establish a uniform approach to personnel dosimetry. The purpose of the standard is to describe minimum levels of acceptable performance and to provide procedures for the performance testing of personnel dosimetry systems.

1.2 Scope

The standard applies only to personnel dosimetry systems used for determining whole-body dose equivalent for the permanent record. The standard is applicable for dosimetry performed for health protection under controlled and uncontrolled conditions (accident dosimetry). Tests for accident dosimetry are approximately represented by the high-dose categories. The performance testing includes categories for the determination of dose equivalent (or absorbed dose) due to ionizing radiation only.

The standard also applies for specific energy intervals. The approximate intervals are from 15 keV to 2 MeV for photons, above 0.3 MeV (average energy) for beta particles, and from 1 keV to 2 MeV for neutrons.

Performance studies for angular dependence (Section 3.3) and lower limit of detectability (Section 3.4) are required one time only for each dosimeter type submitted for evaluation.

NOTE: Performance tests for extremity dosimetry, thermal neutron dosimetry and high-energy neutron dosimetry are excluded from this scope. These categories are planned for inclusion in future revisions of this standard.

1.3 Use

Reference calibration points for personnel dosimetry systems, including energies, source specifications and standard irradiation geometries are defined in sections 2.2, 2.3, and 2.4. The performance criteria defined in section 3.1 shall be used to evaluate dosimeter performance at each reference energy.

Calibrations used for the evaluation of occupational doses or dose equivalents may differ from the reference calibrations. Where such differences exist, the dosimeter's response per unit of delivered dose (or dose equivalent) for the calibration applicable to the occupational environment shall be determined relative to a reference calibration point. Determinations of calibrations specific to occupational environments shall be documented.

A facility should not be required to comply with all portions of this standard if a technical basis for exemption from identified categories is demonstrated.

1.4 Review

The standard shall be reviewed and updated by the Department of Energy (DOE) when considered necessary. Technological advances in both beta and neutron personnel dosimetry practices may allow strengthening of the performance specifications. In addition, it may be desirable to broaden the scope of the standard.

1.5 Definitions

The definitions for many of the terms used in this standard are given below:

Absorbed Dose (D). The energy absorbed per unit mass at a specified point. The special unit is the rad. The SI unit is the gray (Gy). 1 Gy = 100 rad.

Accident Dosimetry. The determination of high levels of absorbed dose resulting from uncontrolled conditions.

Accreditation. The process of evaluating a program which uses personnel dosimeters to measure, report, and record dose equivalents received by radiation workers.

Angular Dependence. The response of a dosimeter as a function of angle of incidence of the radiation detected compared to its response at normal incidence (nonperpendicular incidence).

Applicant. A DOE or DOE laboratory contractor facility which has submitted an application for DOELAP accreditation and is participating in the accreditation process. The dosimetry processor may be the same as the applicant or may be under contract to the applicant to provide the processing service.

Bias (B). The average of the performance quotients, P_i for n dosimeters, for a specified irradiation category and depth

$$B = \frac{1}{n} \sum_{i=1}^{n} P_i \qquad (1)$$

Calibration Specific to Occupational Environment. The dosimeter calibration applicable only to a particular occupational environment. These calibrations are determined by comparing reference measurements to dosimeter response measurements. Both measurements are performed in the work place.

Detection Threshold. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the mean readout value of unirradiated dosimeters.

Dose Equivalent (H). The product of the absorbed dose (D), the quality factor (Q), and any other modifying factors. The special unit is the rem. When D is expressed in Gy, H is in Sieverts (Sv). 1 Sv = 100 rem.

Dosimeter. A combination of absorber(s) and radiation-sensitive element(s) that is used to provide a cumulative record of absorbed dose or dose equivalent received when worn by an individual.

Estimate of Uncertainty (E). The estimated fractional uncertainty of the delivered dose or dose equivalent. The value excludes uncertainties associated with the exposure-to-dose-equivalent conversion factors for photon irradiations, the flux-to-dose equivalent conversion factor for neutron irradiations and the photon component of the neutron irradiations. The testing laboratory calculates this value.

Exposure-to-Dose-Equivalent Conversion Factor for Photons (C_x). The numerical quantity that relates the exposure in air to the dose equivalent at a specified depth in a material of specified geometry and composition. The C_x factors change as a function of photon energy, material geometry (e.g., sphere, slab, or torso), and material composition (e.g., tissue-equivalent plastic, soft tissue ignoring trace elements, or soft tissue including trace elements).

Free-Field Dose Equivalent. The dose equivalent assigned for neutron irradiation as if it were performed in free space with no background due to air and room scattering and no source asymmetry.[5]

High-Dose Range. A performance test range outside the normal operating range. Tests for accident dosimetry capability are conducted within this range

In-Phantom Dose Rate for Beta Sources. The absorbed dose rate at the specified depth inside a tissue-equivalent phantom. Phantom dimensions are assumed to be 30 cm x 30 cm x 5 cm (or greater). The tissue equivalency is for beta radiations.

Irradiation Category. Each type and energy (or mixture) of radiation for which performance criteria are given.

Lower Limit of Detectability. The minimum evaluated dose equivalent for which the readout value of a dosimeter is significantly different (at the 95% confidence level) from the readout value at the detection threshold.

Performance Quotient (P_i). The fractional difference between the reported and delivered absorbed dose or dose equivalent for the i^{th} dosimeter,

$$P_i = \frac{[X_i\,(\text{reported}) - X_i\,(\text{delivered})]}{X_i\,(\text{delivered})} \qquad (2)$$

where D_d, H_s, or H_d can be inserted for X. Here d and s refer to the depth at which D or H is specified, d for deep and s for shallow. The shallow absorbed dose, D_s, is not used in the performance criteria.

Processor. A supplier of personnel dosimetry services. These services include:

- Furnishing dosimeters to the user
- Evaluating the dosimeter readings after their return, in terms of the shallow and deep dose equivalent or the deep absorbed dose as prescribed in this standard
- Recording the results
- Reporting the results to the user.

Protection Dosimetry. Routine measurements and the estimation of the dose equivalent for the purpose of determining and controlling the dose equivalent received by radiation workers.

Shallow and Deep Absorbed Dose (D_s and D_d) or Dose Equivalent (H_s and H_d). The absorbed dose or dose equivalent at the respective depths of 0.007 cm and 1.0 cm in a material of specified geometry and composition.

Standard Deviation (S). The standard deviation of the performance quotients, P_i, calculated for n dosimeters for a specified irradiation category and depth,

$$S = \left[\frac{\sum_{i=1}^{n} (P_i - B)_2}{n-1}\right]^{1/2} \qquad (3)$$

Test. A procedure with the following sequence:

- Applicant submits dosimeters from current stock to a testing laboratory over a period of several months. The number of dosimeters submitted is sufficient for the specified irradiations in a given test category.
- Testing laboratory personnel irradiate the dosimeters using the type(s) of radiation specified for the test category.
- Applicant evaluates the response of the returned dosimeters in terms of shallow and deep dose equivalent for tests of protection monitoring or in terms of deep absorbed dose for tests in high-dose categories.
- Applicant submits these data to the testing laboratory.
- Testing laboratory analyzes the submitted data.
- Testing laboratory reports the results of this analysis (also referred to as "the test results") to the applicant.

Testing Laboratory. A laboratory independent of the applicant's operation, authorized by DOE to carry out the procedures outlined in this standard.

The words *shall*, *should*, and *may* are used as follows in this standard: *shall* denotes a requirement; *should*, a recommendation; and *may*, a permissible practice.

2. TEST PROCEDURES

2.1 Administrative Procedures

The performance tests are administered by the testing laboratory. The administrative procedures are described below.

2.1.1 Information to be Supplied to the Testing Laboratory. The applicant for accreditation shall provide the following:

- The test categories desired with justification(s) for those categories not chosen
- A brief description of dosimeter design, construction, and processing
- An indication of whether the dosimeter is in current use or planned for future use
- Angular-response data required in Section 3.3 and lower limit of detectability data required in Section 3.4 or a plan indicating how these data will be obtained and furnished to the testing laboratory
- Documentation of field calibrations if different from reference sources. The differences between the procedure, calculation, and/or calibration used for reporting occupational exposures shall be provided prior to the test procedure or along with the reported data.

The applicant shall certify that the dosimeters submitted for each test are representative of those supplied routinely to its users.

2.1.2 Number of Test Dosimeters. The applicant shall submit to the testing laboratory either 15 or 30 dosimeters for irradiation in any given test category. Submittal of 30 dosimeters requires a special arrangement with the testing laboratory (see Section 3.1). The dosimeters shall be submitted to the testing laboratory in three shipments. Additional dosimeters shall be included with each dosimeter shipment to serve as shipment controls and replacement spares. Dosimeters may be voided in a test category because of problems caused by the testing laboratory, the applicant, or the processor. The minimum number of irradiated dosimeters required for analysis of a 15-dosimeter test is 13 and for a 30-dosimeter test is 26. If this requirement is not satisfied, statistical analysis of the results in that category shall be delayed until replacement dosimeters have been submitted to the testing laboratory, irradiated, and the results are reported by the applicant to the testing laboratory.

2.1.3 Test Schedule. Each test shall extend over a period ranging from 3 to 6 months. The test dosimeters required for each test category shall be submitted to the testing laboratory in at least three separate groups as the testing laboratory directs. Each group shall be returned by the testing laboratory to the applicant within approximately 1 month of the announced start date for irradiations. Dosimeters submitted late may be included in the following month's irradiations. The applicant shall report the evaluations to the testing laboratory within 45 days of receiving the dosimeters. If this requirement is not met, it may be necessary to void all dosimeter evaluations in the same test category.

2.1.4 Dissemination of Test Results. The testing laboratory shall report all test results to the applicant after the test is completed. An estimate of the uncertainty of the assigned values of the delivered dose equivalent (or absorbed dose) shall be included in the report. The applicant shall not be permitted to change or void the reported values after receiving the test results from the testing laboratory.

2.2 Radiation Sources

The specified irradiations represent the minimum necessary to ensure adequate performance for a multipurpose personnel dosimetry system. Most of the irradiation categories specified and the range of dose equivalents were taken from the American National Standards Institute report ANSI N13.11-1983.[1]

The specifications for the test irradiations closely follow those given in ANSI N13.11. Major differences are: 1) the exposure-to-dose-equivalent conversion factors for photons (C_x) are specified for the calibration geometry; 2) the specifications for the beta source calibrations are more complete; and 3) additional photon, beta, and neutron sources are included. A more comprehensive discussion is presented in Appendix A.

The response of the personnel dosimetry system shall be determined using the following sources:

1. A sealed ^{137}Cs gamma-ray source

   - The irradiation geometry must be adjusted to achieve a shallow depth C_x factor of 1.03 ± 0.05 rem/R.

2. X-ray machine(s) that produce continuous spectra using the U.S. National Bureau of Standards (NBS) techniques[6] and are capable of generating nearly monoenergetic low-energy photon beams (15 to 20 keV and 55 to 65 keV)

   - The operable voltage range is between 30 kV and 160 kV constant potential for the NBS techniques (Table 1). The half-value layer and homogeneity coefficient shall be adjusted to match NBS specifications according to the recommendations in ISO 4037.[7] The half-value layers shall agree to within 2% and the homogeneity coefficients within 4% of the NBS specifications.
   - An ^{241}Am source may be substituted for the 55-keV to 65-keV nearly monoenergetic beam at the discretion of the testing laboratory.
   - The k-fluorescence x-ray technique may be used to generate the nearly monoenergetic beams.[7-9]

3. A sealed $^{90}Sr/^{90}Y$ beta-particle source with 100-mg/cm^2 filtration (nominal) to remove the ^{90}Sr component. It shall meet the following specifications:

Table 1. Reference sources

Source	Energy
Low-Energy Photons	
NBS Filtered Techniques[a]	
M30 (LG)[b]	20 keV (average)
S60 (MFC)[b]	36 keV (average)
M150 (MFI)[b]	70 keV (average)
H150 (HFG)	120 keV (effective)
Monoenergetic[c]	15 to 20 keV
Monoenergetic[c]	55 to 65 keV
^{241}Am[c,d]	59 keV
High-Energy Photons	
^{137}Cs[b]	662 keV
Beta Particles	
^{204}Tl	0.76 MeV (maximum)
$^{90}Sr/^{90}Y$ (filtered)[b]	2.3 MeV (maximum)
Natural or Depleted Uranium[c]	2.3 MeV (maximum)
Neutrons	
^{252}Cf (moderated)[b,e]	
^{252}Cf (unmoderated)	

a. NBS Special Publication 250, Appendix C.[6] The half-value layer and homogeneity coefficient should be adjusted according to the recommendations in ISO 4037.[7]

b. These sources are also specified in ANSI N13.11-1983.[1]

c. These sources were included for specific occupational environments.

d. At the option of the testing laboratory, the ^{241}Am source may be substituted for the [illegible]- to 65-keV monoenergetic source.

e. Moderated by 15 cm of D_2O.[11]

- The residual maximum energy, as defined in the International Standard ISO 6980,[10] shall equal or exceed 1.80 MeV.
- The in-phantom dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 1.01 ± 0.03.
- The in-phantom dose rate at 1000 mg/cm^2 shall be less than 1% of the dose rate at 7 mg/cm^2.
- The dosimetry and energy measurement specifications shall take precedence over irradiation geometry specifications.

4. A sealed ^{204}Tl beta-particle source meeting the following specifications:

   - The residual maximum energy, as defined in ISO 6980, shall equal or exceed 0.53 MeV.
   - The in-phantom dose rate at 20 mg/cm^2 divided by the in-phantom dose rate at 7 mg/cm^2 shall be 0.80 ± 0.05.
   - The dosimetry and energy measurement specifications shall take precedence over the irradiation geometry specifications.

5. A natural or depleted uranium slab meeting the following specifications:

   - The source protective covering shall be in the range between 3 mg/cm^2 and 7 mg/cm^2 inclusive.
   - The dose rate at 100 mg/cm^2 divided by the dose rate at 7 mg/cm^2 shall be 0.58 ± 0.04.
   - The in-phantom dose rate at 1000 mg/cm^2 shall be less than 3% of the dose rate at 7 mg/cm^2.
   - The measurement specification shall take precedence over the geometry specification.
   - The dimensions of the source must exceed the dimensions of the irradiated dosimeters.

6. A ^{252}Cf neutron source used unmoderated and moderated by 15 cm of D_2O covered by 0.05 cm of cadmium.[11]

2.3 Radiation Field Calibrations

Procedures used for calibrating radiation fields shall reference them to source fields standardized by NBS and shall be consistent with accepted national standards and practices. Reference class instruments, as defined in NBS Special Publication 603,[12] or sealed radioactive sources shall be used. (A list of calibration services offered by NBS is included in NBS Special Publication 250.[6]) The testing laboratory shall participate in a Measurement Quality Assurance Program with NBS.

The list of reference sources is given in Table 1. The rationale for selecting the reference calibration sources is discussed in Section A.1 of Appendix A. Requirements for beta calibration spectra are discussed in Section A.2 of Appendix A.

2.3.1 Photon Fields. Photon radiation fields shall be calibrated in terms of exposure in free air. Reference class ionization chambers calibrated by NBS for the particular techniques specified in Table 1 shall be used for the NBS techniques and the ^{137}Cs source. Other photon sources shall be calibrated with a reference class ionization chamber with a measured slowly varying energy dependence which has been calibrated by NBS or intercompared with NBS calibrated chambers in the appropriate energy range.

The dose equivalent assigned to exposed dosimeters shall be calculated using the exposure-to-dose-equivalent conversion factors (C_x) listed in Table 2. (The rationale used for choosing this particular set of C_x factors is given in Appendix A, Section A.3.) Absorbed dose and dose equivalent for radioactive source irradiations shall be calculated:

$$H_s = QC_{x,s}\dot{X}_{air}t; \quad H_d = QC_{x,d}\dot{X}_{air}t; \qquad D_d = C_{x,d}\dot{X}_{air}t \tag{4}$$

where $\dot{X}_{air}$ is the exposure rate in air calibrated using the above procedure, s refers to shallow, d refers to deep, t is the irradiation time and Q is the quality factor (1 Sv/Gy). The shallow dose equivalent rate for ^{137}Cs exposures shall be measured for each source and the irradiation geometry shall be adjusted to achieve a $C_{x,s}$ value of 1.03 ± 0.05 rem/R. The suggested method is with an extrapolation chamber embedded in a methylmethacrylate phantom.

For x-ray exposures referenced to an unsealed monitor ionization chamber,

$$H_s = QC_{x,s}TMC_{TP}; \quad H_d = QC_{x,d}TMC_{TP}; \qquad D_d = C_{x,d}TMC_{TP} \tag{5}$$

Table 2. Exposure-to-dose-equivalent conversion factors for photons[a]

NBS Filtered X-ray Techniques	C_x Conversion Factors, rem/R[b]	
Technique	Shallow (0.007 cm)	Deep (1.0 cm)
M30	1.08	0.45
S60	1.15	1.07
M150	1.41	1.47
H150	1.41	1.41
K-Fluorescence X-ray Techniques		
Energy, keV		
16	1.08	0.38
24	1.07	0.74
34	1.07	0.99
43	1.28	1.30
58	1.47	1.54
78	1.61	1.72
100	1.59	1.74
^{137}Cs		
662	—[c]	1.03

a. Data taken from Yoder et al.[13]

b. The SI unit conversions are 1 rem = 10^{-2} Sv and 1 R = 2.58×10^{-4} C/kg.

c. This value is dependent on source geometry and shall be measured for each source. The irradiation geometry must be adjusted to achieve a value of 1.03 ± 0.05 rem/R.

where T is the exposure-per-charge calibration factor for the monitor chamber at the standard temperature and pressure; M is the reading of the monitor chamber in units of charge; and C_{TP} is the temperature and pressure correction factor for the monitor chamber.

2.3.2 Beta-Particle Fields. Beta-particle fields shall be calibrated in terms of absorbed dose at a tissue depth of 7 mg/cm^2 using a thin-window, tissue-equivalent extrapolation chamber with the appropriate thickness of tissue-equivalent material in front of the window. The extrapolation chamber shall be calibrated using a beta-particle source with a calibration referenced to standards maintained by NBS. A tissue-equivalent extrapolation chamber typically contains a shell, a collecting electrode, and a front window of tissue-equivalent plastic. If air is used in the volume, an appropriate correction factor (stopping power ratio) shall be required.

Calibration depths used for beta irradiations can range from a few tenths of milligrams per square centimeter to 7 mg/cm^2. If a source has been calibrated at depths other than 7 mg/cm^2, measurement of a transmission factor shall be performed. The transmission factor shall be measured with a thin-window ionization chamber or extrapolation chamber. The chamber shall be positioned with its effective center at the calibrated point. Measurements shall then be performed at the depth of calibration and at a depth of 7 mg/cm^2. If material must be added to reach the required measurement depth, it shall be placed in contact with the chamber window. The total material thickness should be within ±0.5 mg/cm^2 of the nominal measurement depth or measurement data collected with greater

and lesser thicknesses shall be used to obtain the correct value by interpolation. The transmission factor shall be calculated as follows:

$$C_{trans} = \frac{\dot{X}(7\ mg/cm^2)}{\dot{X}(d)} \quad (6)$$

where $\dot{X}$ is the relative chamber signal, corrected for temperature and pressure, and d is the original calibration depth.

The dose equivalent assigned to exposed dosimeters shall be calculated using

$$H_s = \dot{D}_t(d) \cdot t \cdot Q \cdot C_{trans} \quad (7)$$

where $\dot{D}_t$, is the absorbed dose rate at the calibration depth d, t is the time, and Q is the quality factor (1 Sv/Gy).

2.3.3 Neutron Fields. The ^{252}Cf sources shall be calibrated in terms of neutron emission rate by NBS or another qualified laboratory using equipment and techniques referenced to NBS-maintained standards. Procedures for calculating the dose equivalent for exposed dosimeters shall follow NBS Special Publication 633.[5] In this publication the free-field dose equivalent (mrem) for unmoderated exposures is defined by:

$$H_d = \frac{N \cdot C_U \cdot t \cdot 3600}{4\pi r^2} \quad (8)$$

where N is the neutron emission rate (n/sec), C_U is the dose-equivalent conversion factor for unmoderated ^{252}Cf (3.33×10^{-5} mrem-cm^2/n), t is the time (h), 3600 is the number of seconds in an hour, and r is the calibration distance (from the source center to the front face of the phantom, cm). For the moderated source,

$$H_d = \frac{N \cdot C_M \cdot t \cdot 3600 \cdot 0.885}{4\pi r^2} \quad (9)$$

where C_M is the dose-equivalent conversion factor for moderated ^{252}Cf (9.08×10^{-6} mrem-cm^2/n), and the 0.885 factor allows for the loss of the number of neutrons moderated below the cadmium cutoff.[14]

NOTE: Ing and Cross[15] quote slightly different values for C_M because they use a lower limit of 1 eV for their calculations. The effect of the neutrons between the cadmium cutoff and 1 eV account for differences in C_M and the neutron loss fraction (see explanation in Schwartz, Eisenhauer and Grundl[16]).

The applicant can obtain direct calibration factor(s) from the testing laboratory. Otherwise, the applicant should consider applying correction factors to the dosimeter readings for air scattering, room return, and source scattering. These techniques are described in NBS Special Publication 633.[5]

The photon component for each irradiation source geometry shall be measured. Unmoderated ^{252}Cf irradiations probably have a greater variation of photon component than the moderated irradiations because of greater relative differences in source filtration. Typical values are 7% of the neutron dose equivalent for unmoderated irradiations[17] and 18% for moderated irradiations.[18]

2.4 Irradiation Geometries and Uncertainties

The dosimeters shall be irradiated using a phantom backing, except for on-contact slab-source exposures. The phantom shall be methylmethacrylate slabs measuring 30 cm x 30 cm x 15 cm for photon calibrations, 30 cm x 30 cm x 5 cm (or greater) for beta-particle calibrations, and 40 cm x 40 cm x 15 cm for neutron calibrations. The dosimeters shall be attached to the surface of the phantom facing the source (front face). For collimated beams, the central beam axis is positioned perpendicular to and passing through the center of the front face of the phantom. For uncollimated beams, the center of the front face of the phantom is positioned perpendicular to a radial line from the source center. Dosimeters shall be mounted with the sensitive elements within the central 15-cm x 15-cm area of the phantom for photon and beta-particle irradiations and within the central 20-cm x 20-cm area for neutron irradiations. The point of calibration shall coincide with the center of the front face of the phantom. The irradiation geometries summarized in Table 3 shall be used.

For photon and beta-particle irradiations, the scatter from the surfaces of the irradiation room and from the source and phantom support hardware shall contribute only a small fraction to the uncertainty in the assigned dose equivalent. If several dosimeters are irradiated simultaneously, precautions shall be taken to keep the mutual interference much smaller than the uncertainty in the assigned dose equivalent.

Table 3. Dosimeter irradiation geometries

Source Type	Phantom Size, cm	Distance, cm[a]	Maximum Useful Area[b]
Photon Sources	30 x 30 x 15		15 cm x 15 cm
^{137}Cs		≥ 100	
NBS filtered x-rays		≥ 100	
Monoenergetic x-rays		≥ 50	
Beta Sources			
$^{90}Sr/^{90}Y$	30 x 30 x ≥ 5	≥ 30	15 cm x 15 cm
^{204}Tl	30 x 30 x ≥ 5	30-50	15 cm x 15 cm
Slab Uranium	—	On contact	—
Neutron Sources	40 x 40 x 15	≥ 50	20 cm x 20 cm

a. Distance from the source center to the front face of the phantom.

b. Position dosimeters so that the sensitive elements fall within the useful area, centered on the front face of the phantom.

The uncertainty in the assigned dose equivalent shall not exceed ± 5%, excluding uncertainties in the dose equivalent conversion factors and the photon component of the neutron irradiations. Dose-rate uniformity measurements shall be performed to determine the useful exposure area. Included in the 5% limit are uncertainties due to source standardization, the uncertainty due to dosimeter position, and the uncertainty due to scattered radiation not stemming from the phantom. The systematic and random uncertainties shall be summed quadratically and separately. The ± 5% limit shall be imposed on the total linear sum of the systematic and random uncertainties. (Refer to Chapter 23 of NBS Handbook 91[19] for guidance on quoting uncertainties.)

NOTE: To achieve a total uncertainty not in excess of ± 5%, it may be necessary to measure and use position-specific correction factors. This can reduce the contribution to the total uncertainty due to dose-rate nonuniformity to an acceptable level.

2.5 Irradiation Level Selection

In each category, the irradiation levels shall be chosen at random using the logarithms of the dose equivalents or absorbed doses. Random selection of the logarithms of the irradiation levels rather than the levels themselves increases the probability of selecting values near the lower limit of the range. Values for the 1-cm depth shall be used except for the beta-particle category or mixtures using beta sources, for which the shallow depth shall be used. In addition, for the categories dealing with mixed radiation fields, the component ratios shall be selected at random. In these categories, the assigned dose equivalent of the larger component shall not be greater than three times that of the smaller component. The test range for the mixture categories specified in Table 4 applies to the summed dose equivalent.

The method for selecting irradiation levels within any one test category and test irradiation range shall be to select random numbers, ρ, between 0 and 1 and to represent the logarithm of the dose equivalent, H, as

$$\log H = \log(H)_\ell + \rho[\log(H)_u - \log(H)_\ell], \qquad (10)$$

where $(H)_\ell$ and $(H)_u$ are the lower and upper limits, respectively, of the range of test irradiation levels in question. The logarithms of absorbed doses shall also be selected using the same method.

Table 4. Irradiation categories

Category	Energy	Test Range	Test Depths
I. Low-Energy Photons (X Ray) - High Dose		10-500 rad	Deep
NBS Filtered Technique			
M150[a]	70 keV[b]		
II. High-Energy Photons - High Dose		10-500 rad	Deep
^{137}Cs[a]	662 keV		
IIIA. Low-Energy Photons (X Ray) - General		0.03-10 rem	Shallow Deep
NBS Filtered Techniques			
M30[a]	20 keV[b]		
S60[a]	36 keV[b]		
M150[a]	70 keV[b]		
H150	120 keV[c]		
IIIB. Low-Energy Photons (X Ray) - Plutonium Environments		0.03-5 rem	Shallow Deep
Monoenergetic	15 to 20 keV		
Monoenergetic	55 to 65 keV		
^{241}Am[d]	59 keV		
IV. High-Energy Photons		0.03-10 rem	Shallow Deep
^{137}Cs[a]	662 keV		
VA. Beta Particles - General (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$ (filtered)[a]	2.3 MeV[f]		
VB. Beta Particles - Special (Slab Geometry)		0.15-5 rem	Shallow
Uranium	2.3 MeV[f]		

Table 4. (continued)

Category	Energy	Test Range	Test Depths
VC. Beta Particles - Special (Point Geometry)		0.15-10 rem	Shallow
^{204}Tl[e]	0.76 MeV[f]		
$^{90}Sr/^{90}Y$	2.3 MeV[f]		
VI. Neutron		0.2-5 rem	Deep
^{252}Cf (moderated)[g]			
^{252}Cf (unmoderated)			
VII. Mixture Categories			
III & IV[a]		0.05-5 rem	Shallow,
III & V	One energy	0.2-5 rem	Deep
IV & V[a]	from each	0.2-5 rem	
III & VI[h]	category	0.3-5 rem	Deep
IV & VI[a]		0.3-5 rem	Deep

a. This category or a subset of this category is also specified in Reference 1.

b. Average.

c. Effective.

d. The ^{241}Am source is optional. At the option of the testing laboratory, it may be used in lieu of the 55- to 65-keV monoenergetic source.

e. A modified performance algorithm is recommended.

f. Maximum.

g. Moderated by 15 cm of D_2O (see Reference 11).

h. For work environments containing plutonium, use the monoenergetic or ^{241}Am sources.

3. PERFORMANCE STANDARDS

3.1 Performance Criteria

Performance in a given category or subcategory (see Table 4) shall be considered adequate if, for the shallow and/or deep dose equivalents (or the deep absorbed dose)

$$|B| + S - |E| \leq L \qquad (11)$$

where B and S designate, respectively, the bias and standard deviation of the performance quotient for the particular category or subcategory, E is the estimation of the fractional uncertainty in the delivered dose or dose equivalent rate, and L is the tolerance level. The values of L shall be the following:

$$L = 0.30 \text{ for Categories I through VI}$$
$$L = 0.40 \text{ for Category VII.} \qquad (12)$$

A modified performance criterion in lieu of Equation (11) shall be acceptable for the ^{204}Tl tests. The ^{204}Tl source shall not be used for mixtures (Category VII). The modified criterion is:

$$|B| - |E| \leq 0.40 \ (^{204}Tl \text{ only}) \qquad (13)$$

The performance criteria in Equations (11), (12) and (13) shall be used until two years after the effective date of the DOE Order.[20] At that time, Equation (12) shall be changed to: "L = 0.30 for all categories" and Equation (13) shall be deleted. The performance criteria for ^{204}Tl shall then be the same (including mixtures) as for the other test sources.

NOTE: The standard of performance is based on achievable standards consistent with the goals of health protection. The test criterion,

$$|B| + S \leq 0.30 \qquad (14)$$

can be interpreted as providing approximately 70% confidence that a dosimeter response would be within 30% of a conventionally true value. However, for workers using four dosimeters annually and receiving approximately the same dose on each, the criterion provides approximately 95% confidence that the annual reported dose equivalent would be within 30% of a conventionally true value. The relationship of this criterion to the recommendations of the National Council on Radiation Protection and Measurements, the International Commission on Radiation Units and Measurements and the International Commission on Radiological Protection are contained in Appendix B.

The estimation of uncertainty (E) was included in the test algorithm to decrease the probability of an inadequate test result being assigned to an adequate dosimetry system. The test applicant receives the benefit of the uncertainty in the delivered dose or dose equivalent.

The ability of a dosimetry system to meet the performance criteria is typically limited by the mixture categories, especially those mixed with the low energy photon category. The tolerance level for mixture categories was set to 0.40 from 0.30 for the first two-year testing period to allow for unexpected difficulties and provides time for adjustments to meet the more stringent criteria to be imposed later.

The test for the low-energy beta source (^{204}Tl) is not required to use Equation (11) for the initial two-year period because of the technological and practical limitations of current dosimeter designs. The ^{204}Tl test algorithm was chosen based on the low-energy beta performance reported by Roberson et al.[3]

The number of dosimeters submitted for a category may be doubled (from 15 to 30) if the fractional standard deviation for that category is greater than 0.15. Determining which categories qualify is the responsibility of the applicant, with concurrence by the testing laboratory (see Section 2.1.2). If the performance of a dosimetry system is found inadequate at the conclusion of a performance test and the estimated probability is greater than 5% that the inadequate result was due to statistical fluctuations in the testing procedure, it shall be so noted on the test results and the applicant should consider submitting 30 dosimeters to that category during the subsequent retest period.

NOTE: The statistical uncertainty of the test results increases with the standard deviation (see Appendix B). Table B.1 of Appendix B lists the (approximate) two standard deviation uncertainties of the test result as a function of the true dosimeter standard deviation and the number of dosimeters used. These values may be used to estimate the probability of an inadequate performance due to

the uncertainties in the test results. Doubling the number of test dosimeters will decrease the effects of the test uncertainties.

The performance test shall be split into three parts in a period not shorter than 3 months and not longer than 6 months (see Section 7.1.3).

NOTE: The standard deviation is composed of dosimeter variations present in a batch of dosimeters read sequentially and the long-term variability of the calibration-plus-readout process. A sampling of the long-term variability is accomplished by splitting the evaluation over a period of time.

3.2 Irradiation Categories

The evaluation of the personnel dosimetry system shall use the categories listed in Table 4. The applicants shall submit dosimeters for testing in the high-dose categories (I and II) corresponding to the similar protection categories (III and IV).

NOTE: The high-dose category corresponding to Category IIIB is Category I due to the difficulty of achieving high-dose levels with nearly monoenergetic sources.

The nearly monoenergetic low-energy photon sources (Category IIIB), the uranium slab source (Category VB), and the special beta point sources (Category VC) were included for application to specific occupational environments. These categories may be used in place of or in addition to Categories IIIA and VA, depending on the occupational environments included in the service. Dosimetry services for an occupational environment containing significant quantities of plutonium shall use Category IIIB. If the same service covers areas with general x-ray sources, Category IIIA shall also be used.

Dosimetry services covering occupational environments containing uranium sources and having an established beta calibration program using slab uranium may use Category VB in place of VA. If the dosimetry service also covers environments with general beta emitters, then testing in Category VA shall be performed.

Category VC shall be used by contractors requiring either a high-energy or low-energy beta source test only. The desired source shall be specified before initiation of the performance test. If both high- and low-energy sources are required, Category VA shall be used. If both low-energy photon categories (IIIA and IIIB) or if two of the beta categories (VA, VB, and/or VC) are required, the dosimetry system may use different algorithms corresponding to those used for the different occupational environments.

If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) and uses the same algorithms for both categories, then only 5 dosimeters shall be submitted for each corresponding mixture category involving those categories. The spectra for those mixture irradiations shall be selected at random from the combined category. If an applicant participates in both low-energy photon categories (IIIA and IIIB) or two of the beta categories (VA, VB and VC) using different algorithms for each category, then 10 dosimeters shall be submitted for each mixture, 5 for each category. In such cases, the applicant shall submit results using both algorithms. The testing laboratory shall choose only the appropriate irradiation categories for the performance test for each algorithm.

NOTE: Category VC was included to accommodate special dosimetry environments. It is expected that the choice of Category VC will be accompanied by a justification. Field measurement data may be required.

The radiation source from Category IIIA and each mixture category involving IIIA shall be chosen for each of the three testing parts at random without replacement. The choice of sources from Category IIIB and each mixture category involving IIIB will alternate for each test part. For each of the Categories IIIA, IIIB, IV, VA, VB, and VC and the mixture categories not using neutrons, the category used for individual irradiated dosimeters shall not be identified to the applicant until after test results are reported to the applicants. In addition, the sources used for the low-energy photon irradiations and the Category VA beta particle irradiations shall not be divulged until the test results are reported.

An applicant participating in neutron tests shall specify which neutron source most appropriately represents the spectral composition of occupational neutron fields which the dosimetry program covers. If both sources are required to adequately represent these neutron fields, the performance testing shall include both sources. The applicant may identify in advance the dosimeters submitted for the neutron tests. When the dosimeters are

returned for evaluation, the participant shall be told which dosimeters were irradiated with neutrons and which source was used. The testing laboratory shall provide pretest calibration exposures for the neutron sources upon request. The testing laboratory shall also provide the ratio of readings from a 9-in.-diameter spherical rem meter and a 3-in.-diameter sphere covered with 10-mil-thick cadmium as a relative calibration for albedo dosimeters.[21]

NOTE: This standard directs the testing laboratory to provide the calibration factor for the neutron performance tests to the applicant. The bias should indicate the ability to calibrate the dosimetry system to an external source. The dosimeter response relative to the testing source(s) and the occupational environments must be documented (see Section 1.3).

3.3 Angular Dependence

For each dosimeter design submitted for testing and for each type of radiation in Categories III through VI for which performance is tested, a study of dosimeter performance when the incident radiation is nonperpendicular shall be carried out once. The study need not be a part of a test series or performed by the testing laboratory. At least two different radiation spectra shall be used in Category IIIA and IIIB; low and mid-range energies should be considered. Category VB is excluded from this requirement. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for Angular Dependence Study. Mount the dosimeters on the front face of the phantom specified for the performance tests. Give identical irradiations to at least two dosimeters of each kind. Vary the angle of incidence in two planes perpendicular to each other and to the plane of the dosimeter in the original test configuration. Vary the angle by rotating the phantom through the appropriate angle. To achieve rotations along the horizontal axis of the dosimeter, rotate the dosimeter 90° on the phantom and rotate the phantom along its vertical axis.

At least seven different angles of incidence from -85° to +85°, including 0° (perpendicular incidence), shall be used in each of the two planes. Values for the dose equivalent for each irradiation exposure should be approximately 500 mrem. For a given angle of incidence and type and energy of incident radiation, the results of the angular dependence study shall be expressed as the ratio of the applicant's dose equivalent interpretation to the actually administered dose equivalent obtained on the basis of perpendicular incidence.

3.4 Lower Limit of Detectability

For each dosimeter design submitted for testing and for at least one source in Categories III through VI for which performance is tested, a study to determine the lower limit of detectability shall be conducted once and reported to the testing laboratory. The study need not be part of a test series or performed by the testing laboratory. The study procedure is given below. No performance criteria shall be applied to the results of this study.

Procedure for the Lower Limit of Detectability Study. At least 10 dosimeters for irradiation per category, plus 10 dosimeters for background evaluation, for each dosimeter design, shall be selected from the routine-processed pool of dosimeters for this study. The dosimeters shall be placed in an unshielded environment for a time sufficient to obtain an unirradiated background signal typical for routine processed dosimeters. At least ten dosimeters shall be irradiated for each category to a dose significantly greater (e.g., 500 mrem) than the estimated lower limit of detectability. Both the irradiated and unirradiated dosimeters shall be processed and evaluated. The following quantities shall be calculated:

$$H_o = \frac{1}{n} \sum_{i=1}^{n} X_{io} \tag{15}$$

$$S_o = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{io} - H_o)^2 \right]^{1/2} \tag{16}$$

$$H_1 = \frac{1}{n} \sum_{i=1}^{n} X_{i1} \tag{17}$$

$$S_1 = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X_{i1} - H_1)^2 \right]^{1/2} \tag{18}$$

where X_{io} = unirradiated dosimeter values and X_i = irradiated dosimeter values. The values H_o and H_1 are the mean evaluated dose equivalent values

for the unirradiated and irradiated dosimeters, respectively, and S_o and S_I are the associated standard deviations. The dosimeter readings shall be processed through the dose algorithms without truncation or distortion (i.e., do not zero any readings). If a background is subtracted, negative values shall be retained for the calculation of S_o. The algorithms for the calculation of shallow and/or deep dose equivalent shall be used to calculate H_o and H_I, depending on the category test specifications. The lower limit of detection, L_D shall be calculated as follows:

$$L_D = 2\,[t_p S_o + (t_p S_I / H_I)^2\, H_o'] \,/\, [1 - (t_p S_I / H_I)^2] \qquad (19)$$

where t_p is the t distribution for n-1 degrees of freedom and a p value of 0.95 (see NBS Handbook 91[19]) and H_o' is the average of the unirradiated dosimeter values without subtracting a background signal.

Alternate Method. If the performance testing was completed within six months of this study, then the values of B and S may be used to calculate [1.75 x S/(1 + B)] which may be used in place of $t_p S_I / H_I$ in Equation (19) for each category. Only a set of unirradiated dosimeters would be required to determine L_D.

NOTE: Equation (19) is based on the desire to minimize both false negative and false positive results. All values below the detection threshold should be set to zero. For example, $t_p S_o$ for p = 0.95 is an estimate of the detection threshold allowing 5% false positive values. For the lower limit of detection false negative values are also minimized. For p = 0.95, the probability of no more than 5% false positive and false negative values provides a lower limit of detection of:

$$L_D = t_{p,o} S_o + t_{p,D} S_D \qquad (20)$$

where S_D is the standard deviation at the lower limit of detectability and $t_{p,o}$ and $t_{p,D}$ depend on the number of dosimeters used to estimate S_o and S_D, respectively.

Equation (20) is an estimate of the equation

$$L_D = K_p \sigma_o + K_p \sigma_D \qquad (21)$$

where σ_o and σ_D are the true standard deviations and K_p is the abscissa of the standard normal distribution below which the total relative area under the curve is P. The σ_D value is composed of the fluctuation of the background (σ_o) and the fluctuation inherent in the readout process. If σ_I / H_I is the relative standard deviation at high doses, then

$$\sigma_D^2 \simeq \sigma_o^2 + \left(\frac{\sigma_I}{H_I}\right)^2 (L_D^2 + 2\, L_D H_o) \qquad (22)$$

and solving for L_D,

$$L_D = 2\left[K_p \sigma_o + \left(K_p \frac{\sigma_I}{H_I}\right)^2 H_o\right] \Big/ \left[1 - \left(K_p \frac{\sigma_I}{H_I}\right)^2\right] \qquad (23)$$

Using t_p for K_p and S for σ, Equation (19) is obtained. If $t_{p,o}$ is not equal to $t_{p,D}$, the formula for L_D is not exact, but should be a close approximation. Additional information can be found in an article by Currie.[22]

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APPENDIX A

CHOICE OF REFERENCE CALIBRATION SOURCES

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Comparisons of occupational exposures reported for various DOE sites are made more difficult by the absence of standard calibration techniques and the use of many dosimeter designs. The establishment of reference calibration techniques will help quantify the effects of differing dosimeter designs and differing occupational environments. The choice of reference sources was based on an intercomparison of dosimeter system performances for DOE laboratories[A-1] and the American National Standards Institute's *Criteria for Testing Personnel Dosimetry Performance*, ANSI N13.11.[A-2] Eleven DOE laboratories participated in the intercomparison to better define present differences and help develop improved techniques.

The intercomparison of dosimetry system performances was also used to evaluate ANSI N13.11 for use by DOE facilities. It was found that: 1) the number of test categories was incomplete; 2) the performance criteria specified did not achieve the goal of the tests as well as other algorithms; 3) the beta-particle category was not sufficiently specified; and 4) the choice of the photon conversion factors was arbitrary. The choice of reference sources was made to be as consistent with ANSI N13.11 as was practical.

A.1 Calibration Categories

The filtered x-ray beams chosen for Table 1 (main text) are National Bureau of Standards (NBS) techniques.[A-3] The M30 (20-keV) and S60 (36-keV) techniques represent the photon energy region of maximum response for most dosimetry systems. They represent a conservative worst-case test for low-energy photons. The M150 (70-keV) and H150 (120-keV) techniques are included to extend the test energies above those influenced by the photoelectric effect. The response of dosimetry systems is similar to that of tissue from approximately 200 keV to 2 MeV because of the dominance of the Compton interaction. Tests at these energies are represented by the high-energy photon category. Nearly monoenergetic x-ray sources at 15 to 20 keV and 55 to 65 keV and the ^{241}Am (59-keV) source were included specifically for facilities using plutonium.

Adequate performance for the ^{90}Sr/^{90}Y beta source does not imply adequate performance for all beta-particle energies. The ^{90}Sr/^{90}Y beta particles are sufficiently energetic to penetrate the popular, thick (235-mg/cm^2) LiF thermoluminescent (TL) dosimeter chip. This penetration results in a response for ^{90}Sr/^{90}Y similar to the response for ^{137}Cs for some dosimeters that are nearly insensitive to low-energy beta particles. Inclusion of the ^{204}Tl source (0.76-MeV maximum energy) requires that some attention be given to the lower energies. Reference sources with energies lower than that provided by the ^{204}Tl source may be included following improvement in dosimeter technology. The ^{204}Tl source was chosen because of its ease of use and single beta spectrum.

A uranium slab source was added for occupational environments containing uranium and because of the popularity of this source type for dosimeter calibrations. Because source construction details may change dose rates slightly, extrapolation chamber measurements were specified for the calibration at 7 mg/cm^2 and the depth-dose determination at 100 mg/cm^2. Source construction and geometry effects are constrained by the depth-dose specification, which was calculated using measurements reported in the literature,[A-4,A-5] and which were subsequently checked by direct measurement. These measurements indicate that the depth-dose specification can be met for slab sources with protective coatings in the range of 3 mg/cm^2 to 7 mg/cm^2.

The use of dosimeters far from a uranium source may result in inaccurate readings compared to the uranium slab calibration. The slab geometry provides a less-penetrating depth-dose distribution than the point source geometry. Proper use of the source calibration can be determined using measurements performed in the occupational environments.

The response ratio of DOE albedo neutron dosimeters for moderated and unmoderated ^{252}Cf irradiations varies from approximately 6 to 20.[A-1] Because the variations are so large, both sources were chosen for use as reference sources. For the performance evaluation, the type of neutron source is provided before the dose equivalents are reported. The moderated ^{252}Cf source was chosen to be consistent with ANSI N13.11. Unmoderated ^{252}Cf irradiations can easily be performed as a variation of the moderated ^{252}Cf irradiations. More

stringent neutron tests may be included following improvements in neutron dosimeter technology.

A.2 Additional Specifications for Beta Calibrations

Beta calibrations are affected by source geometry, source filtration, dosimeter irradiation technique, beam calibration technique, and environmental conditions. The ANSI N13.11 standard specifies inherent source filtration, phantom size, and source-to-phantom distance for $^{90}Sr/^{90}Y$ irradiations but does not adequately address other parameters. Considerable variability in dosimeter response per unit delivered dose has been observed among $^{90}Sr/^{90}Y$ sources set up to ANSI N13.11 specifications. Additional constraints are necessary to standardize beta calibration techniques.

This standard specifies that beta irradiations be standardized according to depth-dose characteristics and source energy criteria in the international standard ISO 6980.[A-6] The specifications for $^{90}Sr/^{90}Y$ irradiation are related to the mean energy of the source (100-mg/cm^2 specification) and Bremsstrahlung production (1000-mg/cm^2 specification). For ^{204}Tl irradiations, only a specification related to mean energy is given (20-mg/cm^2 specification). The depth-dose specifications are intended to take precedence over the source filtration specifications. The intention is to allow the use of source geometries specified in ISO 6980 while maintaining irradiation consistency between laboratories. The depth-dose specification for the slab uranium exposures was added to help control variations in source manufacture and geometry.

A.3 Factors for Converting Exposure to Dose Equivalent for Photons

The exposure-to-dose-equivalent conversion factors for low-energy photons (C_x factors) listed in ANSI N13.11 were derived by Dimbylow and Francis for the four-element ICRU sphere using Monte Carlo calculations.[A-7] For the dosimeter performance tests, the dosimeters are mounted on a slab phantom of methylmethacrylate. Personnel dosimeters are designed to monitor for dose to the tissue of the body on which they are mounted. However, the performance tests require that they monitor for dose to the ICRU sphere while mounted on a slab phantom. This results in the miscalibration of even ideal personnel dosimeters.

The choice of the phantom shape for the specification of C_x factors is not arbitrary, as has been argued.[A-8] The size and shape of the phantom is important for monitoring low-energy photons because radiation is scattered back to the surface. Backscatter can contribute an additional 40% to 50% to the dose at the surface for photon energies between 60 and 100 keV.[A-9] The dosimeter ideally would be able to properly record the level of backscattered radiation and, thus, approximately compensate for fluctuations dependent on the size of the wearer.

The contribution due to backscattered radiation is different for the slab and spherical phantoms. Nelson and Chilton used Monte Carlo calculations to derive the C_x factors for the slab geometry with the ICRU four-element composition.[A-10] Their results agreed closely with the calculations of Dimbylow and Francis (spherical geometry) below 50 keV, but were 20% higher between 80 and 100 keV. This difference accounts for the major discrepancy between the spherical-geometry C_x factors specified in ANSI N13.11 and the available measurements using slab geometry by Yoder et al.[A-11] Nelson and Chilton also performed calculations for the tissue-equivalent plastic used by Yoder et al. for direct measurements of C_x factors using the slab geometry. The significant difference between the calculations for the Yoder plastic and the measurements was at energies below 20 keV. Nelson and Chilton attributed this difference to a higher-energy contamination in the k-fluorescence spectra used by Yoder et al.

Because of the use of slab phantoms for the reference calibrations, conversion factors for the slab geometry are used. The best available data are by Yoder et al. and are listed in Table 2 of the main text.

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APPENDIX B

DERIVATION OF PERFORMANCE CRITERIA

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The specifications of performance criteria were based on achievable standards consistent with the goals of health protection. The criteria were chosen to be both economically and technologically achievable based on the data collected during the intercomparison of dosimeter system performance for DOE laboratories.[B-1] A direct relationship between the performance criterion and the response of each dosimeter was maintained by expressing the criterion as a confidence limit rather than a calibration bias limit only. The confidence limit concept was also used in ANSI N13.11-1983.[B-2] The goal was to develop a statistic for which there would be a specified confidence that the dosimeter readings would be within a specified interval.

For a large number of dosimeter readings obeying a normal distribution, there is a confidence level, β, for which the readings are within the interval

$$M - Z_\alpha \sigma \text{ to } M + Z_\alpha \sigma \qquad \text{(B-1)}$$

where M is the mean; σ is the (one sigma) standard deviation of the total population; and Z_α is the standard normal variable for $\alpha = 1/2\ (\beta + 1)$. The entire interval may be required to be within a specified tolerance of a conventionally true value (CTV) by stating:

$$M + Z_\alpha \sigma \leq CTV\,(1 + L)$$

and

$$M - Z_\alpha \sigma \geq CTV\,(1 - L)$$

or

$$\frac{|M - CTV|}{CTV} + \frac{Z_\alpha \sigma}{CTV} \leq L \qquad \text{(B-2)}$$

where L is the fractional tolerance interval.

For a performance test using n dosimeters, the bias (B) and the standard deviation (S) of the performance indices are estimates of (M - CTV)/CTV and σ/CTV. Then the test statistic becomes

$$|B_n| + t_{\alpha,\nu} S_{n,\nu} \leq L \qquad \text{(B-3)}$$

where ν = n-1 represents the number of degrees of freedom and the 't' statistic is used as an approximation of the standard normal variable due to the finite number of dosimeters used for the test.

The reasonably achievable test statistic chosen for the performance criterion was

$$|B| + S \leq 0.30 \qquad \text{(B-4)}$$

This statistic can be interpreted in several ways. If $t_{\alpha,\nu} = 1$ for n = 15 dosimeters, then there would be approximately 70% confidence (β = 0.66, α = 0.83 for n = 15) that a dosimeter response would be within 30% of a conventionally true value. However, if a worker used four dosimeters per year and received approximately equal doses on each, then there would approximately 95% confidence (β = 0.93, α = 0.97 for n = 15) that the annual reported dose equivalent would be within 30% of a conventionally true value.

Variations of the test statistic derivation are possible. Higher levels of statistical confidence that a test sample is representative of the true population can be obtained using tolerance statistics.[B-3] An interval can be constructed to cover at least a specified percent of all dosimeter readings in the total population with a desired probability. For example, for a 95% probability that 95% of the averages of four dosimeter readings are within tolerance (assuming uniform occupational exposures and a quarterly exchange rate), the test statistic becomes:

$$|B| + 1.45\,S \leq 0.30 \qquad \text{(B-5)}$$

for 15 sample readings. However, there is also the probability that a system that meets the 30% criteria exceeds the test statistic. For 95% probability that systems meeting requirements also meet the test statistic, the tolerance value (0.30) would have to be increased. Both approaches converge to the adopted test statistic as the number of sample dosimeters approaches infinity.

The relationship of the adopted test statistic (Equation B-4) to recommendations of the NCRP, ICRU and ICRP are given below.

Recommendations to NCRP 57[B-4]

The NCRP recommends several values of precision and accuracy depending on the circumstance. The recommended precision is ± 10% which allows comparison of reported values between individuals and over long periods of time. For reported values near the maximum permissible dose (MPD), an accuracy of ± 30% is recommended. For reported values less than 1/4 of the MPD, an accuracy of a factor of 2 is acceptable. At higher doses encountered during emergency procedures or accidents, an accuracy of better than ± 20% is recommended.

The precision of the reported values approximately corresponds to the 'S' value. While the test statistic does not require an S of 0.10 or less, there is an implied constraint on S of about 0.12 to 0.15. Larger values of S do not allow sufficient latitude for a minimal uncertainty in the bias, especially for multipurpose dosimeters which require some latitude in the bias to cover response variation as a function of radiation type and energy. The spirit of the recommendation for precision is accommodated.

The recommended accuracy near the MPD of 30% is implied to be used annually, since the MPD is applied annually. If a facility uses quarterly dosimeter exchanges, dosimeters receiving approximately equal doses per quarter would meet the 30% recommendations with approximately 95% confidence. The reported dose equivalent for a worker receiving all of the annual dose on one dosimeter would have an approximately 70% confidence of meeting the recommendation.

A test statistic variable in the magnitude of the delivered dose was contained in the early drafts of ANSI N13.11. The University of Michigan test concluded, and the DOE study concurred, that the split in the test statistic was unnecessary at current state of the art and was detrimental to the conduct of the test. Principally, a significantly larger number of dosimeters would be required to perform a variable-criteria test compared to a single-criteria test to achieve the same level of confidence in the results. Therefore, the allowance for a greater inaccuracy at lower doses was not included in the test criteria.

The test statistic does not meet the ± 20% recommendation on the accuracy at high doses. High doses are typically received by only one dosimeter, thus there would be 70% confidence that the reported dose is within 30%.

Recommendations in ICRU 20[B-5]

The ICRU recommends that an accuracy of ± 30% be achieved when the maximum dose equivalent is comparable to the maximum permissible dose. At a level of 0.1 of the maximum permissible dose, a maximum allowable uncertainty of a factor of three is suggested. At doses much greater than the maximum permissible dose, the ICRU recommends that the accuracy be increased, possibly with special effort applied postexposure.

The accuracy recommended by the ICRU is similar to that quoted by the NCRP at radiation protection levels. At high doses, the ICRU encourages the use of special efforts to improve the dose estimate for each individual worker. The adopted test criteria is in approximate agreement with these recommendations. However, there is no test requirement to demonstrate the ability to improve the accuracy after the exposure.

Recommendations in ICRP 35[B-6]

The ICRP recommends that the uncertainty in the annual reported dose equivalent be reduced as far as is reasonably achievable. It further recommends minimum levels of accuracy of a factor of 1.5 at the 95% confidence limit when the dose equivalent is on the same order as the annual maximum permissible dose, or within a factor of two at the 95% confidence level when the annual reported dose is less than 1 rem. Explicitly stated is that these accuracy limits include variations in dosimeter sensitivity, with incident energy and direction of incidence, and in dosimeter construction, readout, and calibration.

The first recommendation is met: the criteria was designed to be as low as is reasonably achievable. The recommended minimum levels of accuracy near the maximum permissible dose imply a test statistic of

$$|B| + 2S \leq 0.50 \text{ for B positive}$$

and (B-6)

$$|B| + 2S \leq 0.33 \text{ for B negative.}$$

The asymmetric criterion is due to the specification of a factor rather than a percent of the conventionally true value. This statistic implies an upper limit of S of 0.25, which is approximately achieved by

the adopted statistic (S_{max} = 0.30). The adopted criteria approximately corresponds to recommendations of the ICRP for S values near 0.20. However, the allowed inaccuracy of the bias for small S values is (nearly) as great as 50%. This allows too much inaccuracy in the calibration methods and dosimeter design, and is above the currently achievable level. Note that this approach does not require the use of quarterly dosimeter exchanges with the accompanying assumption of approximately equal doses received each quarter.

A source of inaccuracy included by the ICRP, but not included by the adopted test criteria is that due to direction of radiation incidence. The collection of angular response data is required by the DOE standard with no criteria on the performance. The application of the adopted test statistic may be alternatively viewed as allowing a confidence interval up to 0.2 for the inaccuracy in the angular response. The recommendations of the ICRP can be taken into account during the development and subsequent review of a test criteria for angular response.

The recommendations at the lower dose equivalent levels were not used for the same reason as was stated above for the NCRP recommendations.

Summary of Relationship to NCRP/ICRU/ICRP Recommendations[B-4 through B-6]

The adopted performance criteria were chosen to be as low as was reasonably achievable. The criterion is consistent with the recommendations of the NCRP,[B-4] ICRU,[B-5] and ICRP[B-6] within the following caveats:

- To meet the NCRP and ICRU recommendations of 30% for the accuracy, and do it with 95% confidence, at least four dosimeters receiving equal doses must be used. This may be approximately correct for the majority of workers, but is not adequate for all.
- The recommendations by the ICRP are approximately met for each dosimeter, and thus for each worker, except that the uncertainty due to angular response is neglected in the test criteria. The adopted test criteria are approximately equivalent to reserving up to 20% for additional (positive) bias due to angular response variations.
- The NCRP recommended accuracy in the high dose region is greater than is specified by the test criteria (20% NCRP versus 30% test criteria). The ICRU and ICRP favor special effort to increase accuracy on a case-by-case basis.
- Inaccuracies resulting from field use under partially unknown conditions (e.g., position of dosimeter relative to the source distribution and body of wearer) are neglected in the test criteria.

Performance Test Uncertainty

The implementation of the test statistic as given in Equation (B.4) may require large numbers of dosimeters to measure |B| and S with sufficient precision. Assuming that the dosimeter readings are normally distributed about a single mean, for 95% of the readings the magnitude of the bias is bounded by:

$$|B| \leq \frac{|M - CTV|}{CTV} + \frac{Z_{0.975}}{\sqrt{n}} \frac{\sigma}{CTV} \qquad \text{(B-7)}$$

For 95% of the samples the standard deviation is approximately bounded by:

$$S \leq \left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} \cdot \frac{\sigma}{CTV} \qquad \text{(B-8)}$$

using a χ^2 distribution with (n - 1) degrees of freedom. Because the uncertainties in B and S are independent for normally distributed data, a close approximation to the interval containing 95% of the parent population is:

$$[|B| + S]_{max} = \frac{|M - CTV|}{CTV} + \frac{\sigma}{CTV} + \left\{ \left(\frac{Z_{0.975}}{n} \right)^2 + \left[\left(\frac{\chi^2_{0.95}}{n - 1} \right)^{1/2} - 1 \right]^2 \right\}^{1/2} \frac{\sigma}{CTV} \qquad \text{(B-9)}$$

The term in brackets on the right-hand side is the amount by which a system that meets the goals for accuracy could fail the test statistic due to a statistical fluctuation of a measurement. This term can be

Table B-1. Statistical uncertainty term

σ/CTV	Number of Dosimeters	Approximate Value of Uncertainty Term
0.08	15	0.05
0.17	15	0.10
	30	0.17
	60	0.05
0.24	15	0.14
	30	0.10
	60	0.07
	120	0.05

reduced by increasing the number of dosimeters per test. Table B.1 lists the approximate values of the statistical terms as a function of σ and the number of dosimeters used per test. For an uncertainty of 5%, 15, 60, and 120 dosimeters are required for standard deviations of 0.08, 0.17, and 0.24, respectively. Similar requirements for the number of sample dosimeters can be derived using tolerance statistics for 95% probability that 70% of a parent population with $|B| + S = 0.25$ is within tolerance.

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A. C. Davis, Manager
Bettis Atomic Power Laboratory, Westinghouse Electric Corporation, P.O. Box 79, West Mifflin, PA

C. K. Gaddis, Manager
Pittsburgh Naval Reactors Office, P.O. Box 109, West Mifflin, PA

A. Richardson, EPA Office of Radiation Protection, Criteria & Standards Division, AW-460, 401 M Street, SW, Washington, DC

J. T. Lewis, Center for Dev. & Radiol. Health, Office of Health Physics, HFZ-60, Rm. Chap. 332, 5600 Fishers Lane, Rockville, MD

J. C. Villforth, Director
FDA Bureau of Radiological Health, Rockville, MD

R. Colle, National Bureau of Standards, Gaithersburg, MD

E. H. Eisenhower, Office of Radiation Measurement, National Bureau of Standards, Gaithersburg, MD

Don Busick, Stanford Linear Accelerator, P.O. Box 4349, Stanford, CA

Bob Tuttle, Rockwell International, Rocketdyne Division, 6633 Canoga Ave., Canoga Park, CA

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Paul Matthews, U.S. Department of Energy, Savannah River Operations Office, P.O. Box A, Aiken, SC

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A. Brodsky, U.S. Nuclear Regulatory Commission, Wilste Bldg., MS-1130 SS, 7515 Eastern Ave., Silver Spring, MD

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L. F. Phillips, Building 535A, Brookhaven National Laboratory, Upton, NY

D. J. Thompson, Sandia National Laboratories, Organization 3313, P.O. Box 5800, Albuquerque, NM

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Idaho Falls, ID

C. D. Sorensen
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID

C. S. Abrams
Argonne National Laboratory
Idaho Site
P.O. Box 2528
Idaho Falls, ID

Amendment No. 22

MATERIALS LICENSE

FILE COPY

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law [illegible]), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Environmental Protection Agency Office of Research and Development National Exposure Research Laboratory 2. Characterization Research Division P.O. Box 93478 Las Vegas, NV 89193-3478	In accordance with letter dated November 9, 1995, 3. License number 27-05861-02 is amended in its entirety to read as follows:
	4. Expiration date February 28, 1994
	5. Docket or Reference No. 030-06981

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Hydrogen 3	A. Any	A. 5 millicuries
B. Any byproduct material with Atomic Nos. 3-83, and with half-lives less than or equal to 120 days	B. Any	B. Not to exceed 5 millicuries per radionuclide
C. Any byproduct material with Atomic Nos. 3-83 with half-lives greater than 120 days	C. Any	C. Not to exceed 1 millicurie per radionuclide and 25 millicuries total
D. Any byproduct material with Atomic Nos. 3-83	D. Sealed and/or plated sources	D. Not to exceed 5 millicuries per source and 100 millicuries total
E. Carbon 14	E. Any	E. 10 millicuries
F. Strontium 90	F. Any	F. 200 microcuries
G. Iodine 129	G. Any	G. 50 microcuries
H. Any byproduct, source or special nuclear material with Atomic Nos. 84-96	H. Any	H. Not to exceed 100 microcuries per radionuclide and 10 millicuries total

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(continued)

I.	Any byproduct, source or special nuclear material with Atomic Nos. 84-96	I.	Sealed and/or plated sources	I.	Not to exceed 100 microcuries per source and 10 millicuries total
J.	Polonium 210	J.	Any	J.	650 microcuries
K.	Uranium 233	K.	Any	K.	10 microcuries
L.	Uranium 235	L.	Any	L.	10 microcuries
M.	Plutonium 236	M.	Any	M.	10 microcuries
N.	Plutonium 238	N.	Any	N.	60 microcuries
O.	Plutonium 239	O.	Any	O.	30 microcuries
P.	Plutonium 240	P.	Any	P.	10 microcuries
Q.	Plutonium 241	Q.	Any	Q.	10 microcuries
R.	Plutonium 242	R.	Any	R.	10 microcuries
S.	Plutonium 244	S.	Any	S.	5 microcuries
T.	Source material	T.	Any	T.	15 pounds
U.	Nickel 63	U.	Foils or plated sources in detector cells	U.	1 curie
V.	Cesium 137	V.	Sealed source (U.S. Nuclear Model 375)	V.	1 millicurie
W.	Cobalt 60	W.	Sealed source (U.S. Nuclear Model 375)	W.	5 millicuries
X.	Cesium 137	X.	Sealed source (U.S. Nuclear Model 375)	X.	300 millicuries
Y.	Cesium 137	Y.	Sealed source (New England Nuclear Model NER-572)	Y.	10 millicuries

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(continued)

Z. Cesium 137	Z. J. L. Shepherd and Associates Series 6810 sealed sources (Reference Dwg. No. A-0348 dated July 24, 1976)	Z. Six sources consisting of the following activities: 10 curies, 1 curie, 100 millicuries, 10 millicuries (2 sources) and 1 millicurie
AA. Plutonium 239	AA. Sealed or plated sources	AA. Not to exceed 5 microcuries per source and 100 microcuries total
BB. Hydrogen 3	BB. Titanium tritide foils in detector cells	BB. 5 curies
CC. Cesium 137	CC. Sealed source	CC. 100 millicuries
DD. Cesium 137	DD. Sealed source (Amersham Model CDC.711M Series)	DD. Not to exceed 3 curies per source and 6 curies total
EE. Cesium 137	EE. Sealed sources (NEN Model G316 B capsule and a J.L. Shepherd and Associates Type 6810 capsule, both reencapsulated in one source holder)	EE. 751 millicuries
FF. Americium 241	FF. Sealed sources (Amersham Model AMC.D2)	FF. Not to exceed 30 millicuries per source and 60 millicuries total
GG. Curium 244	GG. Sealed sources (Amersham Model CLCL or Isotope Products Model XFB series)	GG. Not to exceed 100 millicuries per source and 200 millicuries total

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9. Authorized Use

A. through T. To be used in laboratory and tracer studies and analysis; development and standardization of chemical procedures; instrument calibration; research and development as defined in 10 CFR Part 30.4; preparation and distribution of radioanalysis calibration standards and environmental-level laboratory intercomparison samples; and the local fabrication of subnanocurie electrodeposited sources for calibrations. Sealed sources may also be used for demonstration and training purposes in the laboratory and field.

U. To be used in gas chromatographs for sample analysis.

V. and W. To be used in J. L. Shepherd Model 28-5 devices for instrument calibration.

X. To be used in J. L. Shepherd Model 142-10 irradiator for instrument calibration.

Y. For storage only in a Mount Sopris Model 1000-C Portable Borehole Logger.

Z. For use in two concrete shielding wells for instrument and dosimetry calibration.

AA. For instrument calibration.

BB. To be used in gas chromatographs for sample analysis.

CC. For use in panoramic device for TLD and Pocket Dosimeter Calibration.

DD. To be used in a Williston Elin self shielding TLD irradiator to irradiate Panasonic TLDS.

EE. To be used in a J.L. Shepherd Model 89 Series Calibrator within a J.L. Shepherd Model 78 Series Self-Contained Calibration Facility for instrument calibration.

FF. and GG. To be used in Columbia Scientific Industries Corp. portable X-ray analyzer Model 880 for analysis of metal contaminants in soil and ground water.

CONDITIONS

10. Licensed material shall be used only at the licensee's facilities located at 944 East Harmon Avenue, Las Vegas, Nevada or the Department of Energy's Nevada Test Site, 65 miles northwest of Las Vegas, except:

    A. Sealed sources listed in Subitems B. through U. may be used for instrument calibration at the licensee's facilities at 4220 South Maryland Parkway, Building C; Las Vegas, Nevada.

    B. Sealed sources listed on this license which have individual activities less than those listed in Schedule B of 10 CFR 30.71 may be used for instrument calibration and demonstration at temporary job sites of the licensee anywhere in the United States.

    C. Sealed sources listed in Subitems Z. and CC. may be used only at the licensee's facilities at 944 East Harmon Avenue, Las Vegas, Nevada.

    D. Sealed sources listed in Subitem W. and EE. may be used for instrument calibration at temporary job sites of the licensee anywhere in the United States.

    E. Sealed sources listed in Subitems FF. and GG. may be used for soil and ground water analysis at temporary job sites of the licensee anywhere in the United States.

11. A. Licensed material shall only be used by, or under the supervision of, individuals designated by the Radiation Safety Committee, Stephen H. Pia, Chairperson.

    B. The Radiation Safety Officer for this license is Loyd D. Carroll.

12. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

    B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

    C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

(continued)

D. Each sealed source fabricated by the licensee shall be inspected and tested for construction defects, leakage, and contamination prior to any use or transfer as a sealed source.

E. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

(iv) they contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

(v) they are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transferred to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

F. The leak test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30(b)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. The report shall be filed within 5 days of the date the leak test result is known with the U.S. Nuclear Regulatory Commission, Region IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011, ATTN: Director, Division of Radiation Safety and Safeguards. The report shall specify the source involved, the test results, and corrective action taken.

G. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically licensed by the Commission or an Agreement State to perform such services.

13. Sealed sources or detector cells containing licensed material shall not be opened or sources removed from source holders by the licensee.

14. The roof of the calibration facility (over Room 18 of the Monitoring Systems Laboratory, at 944 East Harmon Avenue, Las Vegas, Nevada) shall be fenced and posted "Caution Radiation Area."

15. In lieu of using the conventional radiation caution colors (magenta or purple on yellow background) as provided in 10 CFR 20.203(a)(1), the licensee is hereby authorized to label detector cells, containing licensed material and used in gas chromatography devices, with conspicuously etched or stamped radiation caution symbols.

16. Maintenance, repair, cleaning, replacement and disposal of foils contained in detector cells shall be performed only by the device manufacturer or other persons specifically authorized by the Commission or an Agreement State to perform such services.

17. A. Detector cells containing a titanium tritide foil or a scandium tritide foil shall only be used in conjunction with a properly operating temperature control mechanism which prevents the foil temperature from exceeding that specified by the manufacturer and approved by NRC.

B. When in use, detector cells containing a titanium tritide foil or a scandium tritide foil shall be vented to the outside.

18. Each source holder or logging tool containing radioactive material shall bear a legible and visible marking as specified in 10 CFR 39.31(a). The label must be on the smallest component that contains the licensed material which is transported as a separate piece of equipment.

19. Licensed material shall not be used in or on human beings.

20. The licensee shall not use licensed material in field applications where activity is released except as provided otherwise by specific condition of this license.

21. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under the license.

22. The licensee is authorized to transport licensed material only in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

23. The licensee shall maintain records of information related to decommissioning at 944 East Harmon Avenue, Chemistry Building; Las Vegas, Nevada as specified in 10 CFR 30.35(g), 40.36(f), and 70.25(g) until this license is terminated by the Commission.

24. In addition to the possession limits in Item 8, the licensee shall further restrict the possession of licensed material to quantities below the minimum limit specified in 10 CFR 30.35(d) or 40.36(b) or 70.25(d) for establishing decommissioning financial assurance.

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25. Notwithstanding the requirements of 10 CFR 20.202(c), the licensee may use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

26. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Application dated January 3, 1989
B. Letter dated March 13, 1989
C. Letter dated April 19, 1990
D. Letter dated July 26, 1990
E. Letter dated October 15, 1990
F. Letter dated November 9, 1990
G. Letter dated May 8, 1991
H. Letter dated December 19, 1991
I. Letter dated January 7, 1992
J. Letter dated April 7, 1992
K. Telefacsimile dated April 29, 1992
L. Letter dated July 17, 1992
M. Letter dated July 27, 1993
N. Letter dated September 7, 1993
O. Letter dated November 12, 1993
P. Letter dated August 19, 1994
Q. Letter dated October 5, 1994
R. Letter dated October 12, 1994
S. Letter dated April 7, 1995
T. Letter dated April 20, 1995
U. Letter dated November 9, 1995

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date NOV 2 8 1995

By James L. Montgomery
Materials Branch
Region IV, WCFO
Walnut Creek, California 94596

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

July 10, 1996

MEMORANDUM TO: Donald A. Cool, Director
Division of Industrial and Medical Nuclear Safety, NMSS

FROM: Frank A. Wenslawski, Chief
Materials Branch

SUBJECT: TECHNICAL ASSISTANCE REQUEST: EPA, LAS VEGAS
CONTROL 571951

This Technical Assistance Request (TAR) is sent to you to determine whether an exemption from 10 CFR 20.202(c)--now 10 CFR 20.1501(c)--can be continued when the license is renewed (the license is in timely renewal status). License Condition 25. currently allows the licensee to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP). This matter was previously sent to Headquarters in a TAR dated January 23, 1992. In a response dated March 24, 1992, it was stated that Headquarters had reviewed the DOELAP program and had determined that it satisfied the criteria outlined in NVLAP. For this reason, it was recommended that EPA's request be approved.

We recommend that their request for renewal of this exemption be granted. If their request cannot be granted, please specify the reasons.

If further information is required, contact Beth Prange at (510) 975-0250.

Enclosures:

TAR Form dated July 9, 1996
Letter dated July 3, 1996
Handbook for the DOELAP for Personnel Dosimetry Systems
DOE Standard for the Performance Testing of Personnel Dosimetry Systems
Amendment No. 22 to License No. 27-05861-02

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: July 9, 1996

Mail or E-Mail to: Donald A. Cool, Mail Stop: TWFN 9F5 If E-mail, cc: DAC
Division of Industrial and Medical Nuclear Safety, NMSS

From: Frank A. Wenslawski (FAW) Region IV, WCFO
Chief, Materials Branch

Licensee: EPA, Las Vegas License No.: 27-05861-02

Control No. 571951

Letter dated: July 3, 1996

☐ Problem/Issue: The licensee wishes to renew an exemption from 10 CFR 20.202(c)---now 10 CFR 20.1501(c)---to allow them to use the Department of Energy Laboratory Accreditation Program (DOELAP) rather than the National Voluntary Laboratory Accreditation Program (NVLAP).

☐ Action Required: Review their request and determine whether the exemption can be continued. If not, specify the reasons.

Recommended Action (with revisions): X Approve

Headquarter Reviewer: (For HQ use)
Regional Reviewer: Beth Prange (BAP1)
Reviewer Code: W1
Reviewer Phone No.: (510)975-0250 FAX No.: (510)975-0381
Request Needed by: 09/09/96

Form TAR-10
9/93

ORC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

JUL 30 1996

U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division
ATTN: Wayne Marchant
Director
P.O. Box 93478
Las Vegas, Nevada 89193-3478

SUBJECT: RESPONSE TO LETTER DATED JULY 24, 1996

We believe that October 14, 1996 is a reasonable target date for the resubmission of your license application.

The expected interactions of the Radiation Safety Officer (RSO), the Radiation Safety Committee (RSC), and management are clearly specified in Item 7 and in Appendices F, G, H, and K of the enclosed draft regulatory guide for broad scope license applications. These interactions are described further in NUREG-1516, "Management of Radioactive Material Safety Programs at Medical Facilities", also enclosed. While the NUREG document was written with medical facilities in mind, it can be used to determine the ways NRC expects licensee radiation safety programs to function. The ability of the RSO to communicate freely with the highest levels of management and with the RSC on matters of radiation safety and health is vital to the success of your licensed program. Management, the RSC, and the RSO should function as a team on radiation safety matters.

Where day-to-day employee relations are of concern, rather than radiation safety issues, it is appropriate to follow your own internal personnel procedures. NRC does not routinely become involved in personnel issues or organizational concerns. These matters are outside our normal responsibilities to ensure employee and public radiologic health and safety. Choosing the appropriate level of management for your RSO to report to for routine employee-relations issues is not within our area of responsibility.

We hope that this reply is fully responsive to your concerns.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Enclosures: As Stated

Docket: 030-06981
License: 27-05861-02
Control: 571951

bcc:

Docket File
WCFO Inspection File
LFDCB, T-9 E10

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

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July 24, 1996

OFFICE OF
RESEARCH AND DEVELOPMENT

Ms. Beth Prange
Senior Health Physicist, Licensing
Materials Branch
United States Nuclear Regulatory Commission - Region IV
1450 Maria Lane
Walnut Creek, CA 94596-5368

Dear Ms. Prange:

During our teleconference July 1, 1996, I committed to submit a revised license application in a reasonable time. This has been, and remains, a very high priority for me. However, it is inherently difficult and time-consuming. Moreover, the press of other work and a scheduled absence of our RSO will delay our submission until the week of October 14, 1996, if not sooner. Please let me know if this creates a problem.

On a related matter, for some time I have been discussing with my staff the appropriate reporting relationship for the RSO. Rightly or wrongly, I had believed that he must report directly to me or to my associate laboratory director, at least with respect to matters directly related to RSO duties (as contrasted with other radiation work). I use the term "report" in its technical sense to mean report for performance appraisal, leave approval, discipline, travel approval, and the like. But this is administratively awkward, and not like other reporting relationships in my laboratory. For example, it is extraordinary for an employee at grade GS-12 to report directly to a member of the Senior Executive Service, which I am. I have been interested in the possibility of assigning the supervision of the RSO to one of my middle managers. This would bring management of the professional conduct and technical performance of the RSO in line with other management practices at my laboratory. Additionally, conduct and technical expertise can then be evaluated routinely as with any employee. It has not been clear how to distinguish the non-management health and safety responsibilities of the RSO from the general standards required of every employee.

I understand that Stephen Pia has discussed this matter with you and Jim Montgomery. Steve commented about how helpful and informative those conversations were. In his summary to me, Steve said it was clear that as long as the RSO has the authority and responsibility to report to me or my associate, and to the radiation safety committee (RSC), concerning health and safety, he can be supervised by another manager. This would include supervision of tasks assigned to the RSO where health and safety are not the central issue as well as the RSO's professional conduct with and technical assistance to the authorized users. Preparation of the license application is one example where supervision of progress is important. It was also emphasized that the RSC is responsible to review the RSO's administration of the provisions of the safety program. I always have supported, and I continue to support, the RSO when it comes

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to matters of health and safety. He has immediate and unrestricted access to me and to all levels of management both locally and as high in the chain of command external to our facility as is required to ensure a safe workplace.

If this information is correct I intend to assign the RSO to a supervisor in the unit where the RSO is attached. However, before I move forward with this reassignment I would appreciate confirmation by the NRC that this would not be viewed as inappropriate.

I look forward to your reply. Please feel free to call (702) 798-2525 if you want to discuss this or any related issue.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

cc:
Stephen Pia
Christian Daughton

U.S. NUCLEAR REGULATORY COMMISSION
REGION V

DATE ~~00/00/00~~ 7/1/96

TELEPHONE OR VERBAL CONVERSATION RECORD

TIME 1:30 ~~00:00~~ am/(pm)

[ ] INCOMING CALL [X] OUTGOING CALL [ ] VISIT

PERSON CALLING:	OFFICE/ADDRESS:	PHONE NUMBER:

PERSON CALLED:	OFFICE/ADDRESS:	PHONE NUMBER:
Wayne Marchant		(702) 798-2525

CONVERSATION

SUBJECT - EPA Las Vegas Licensee renewal

SUMMARY -

F. Wenslawski and B. Prange participated from WCFO.
Wayne Marchant, John Moore, Steve Pia, and Loyd Carroll participated from Las Vegas.

The deficiency letter dated May 28, 1996 was discussed. In particular, exemption requests, Statements of Intent, RSO responsibilities, inventories, decay-in-storage, waste disposal, and the need to submit a complete renewal request were discussed.

The licensee will submit a target date for completion of the renewal effort as well as will a request to continue the exemption from 10CFR 20.202(c) — 20.1501.

- B. Prange

REFERRED TO:	[ ] ADVISE ME ON ACTION TAKEN
ACTION REQUESTED:	INITIALS:
	DATE:
ACTION TAKEN:	INITIALS:
	DATE:

NRC FORM 218 REV-0 8/93 [WP/bdc-RIV]

ORC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

MAY 28 1996

U.S. Environmental Protection Agency
National Exposure Research Laboratory
Characterization Research Division
ATTN: Wayne Marchant
Director
P.O. Box 93478
Las Vegas, Nevada 89193-3478

SUBJECT: LICENSE RENEWAL

This is in reference to your request dated April 3, 1996 for renewal of your byproduct material license. It should be noted that your original renewal request was dated February 11, 1994. That application was withdrawn by your letter dated February 1, 1995. This matter was also discussed in letters from you dated November 28, 1994 and February 15, 1996 and in correspondence from NRC dated January 20, 1995 and February 15, 1995. A letter stating that your license is currently in timely renewal was issued on March 7, 1994.

During the review of your most recent renewal request, it was noted that the application is not a stand-alone document, as it refers to other documents in several sections (Items 5, 6, 9, and 10). These documents include the application dated January 3, 1989, the license and existing amendments, your general emergency response plan, your radiation safety manual, and IAEA Safety Standard, Safety Series No.1. In addition, License Condition 26. of Amendment 22 to License 27-05861-02 currently lists twenty-one documents which are part of your current license file. Thus, the license is fragmented and awkward to reference. We feel that it is important that the license renewal be a coherent, concise document.

It was also noted that certain procedures and criteria outlined in Draft Regulatory Guide DG-0005, dated October 1994, "Applications for Licenses of Broad Scope", copy enclosed, were either covered in your submittal in a cursory, generic manner, or not at all. We will list our specific concerns later in this letter. A copy of the checklist used to review your application is enclosed for your reference so that the procedures and criteria which NRC expects to be included in an application are easily identified.

After some consideration, we are asking you to resubmit your renewal application in its entirety without referencing other documents. If previous information remains accurate, it is acceptable to copy the information and to include it as an appendix to your submittal. Please note, however, that many changes have occurred in your program since the last renewal that may warrant revisions to such documents. We believe that taking the extra effort to draft a complete renewal request will produce an unambiguous license that will be much more useful to your personnel. We feel that the resulting improvement in the final licensing product outweighs the additional delay in its timeliness. Upon receipt of this letter, we ask that you review our concerns, determine a reasonable target date for resubmission of your renewal request, and inform us in writing of the chosen date. If extensions are necessary, we request that you also inform us in writing, describing the reasons for the delay.

The exemption from the requirements of 10 CFR 20.202(c) (now 10 CFR 20.1501), which is currently listed as License Condition 25. in your license, will have to be renewed. This must be accomplished by written approval from NRC Headquarters. In your reply, specify whether the following documents remain current:

> Handbook for the Department of Energy Laboratory Accreditation program for Personnel Dosimetry Systems, published December 1986, DOE/EH-0026.
>
> Department of Energy Standard for the Performance Testing of Personnel Dosimetry Systems, published December 1986, DOE/EH-0027.

If they have been updated, please forward current versions of those documents, as they will be forwarded to Headquarters for reconsideration.

In Item 9. of your renewal application, you requested that the Special Use Isotope Facility (Hot Lab) in Room 46 of the Quality Assurance Laboratory Building be deleted from the license. You should submit a copy of the close-out survey and information concerning the licensed materials which were used in the area, the instrumentation used for the close-out surveys, instrument efficiencies, instrument calibrations, the type of surveys performed, and the minimum detectable activities for each type of survey. Enough information should be provided to demonstrate that the guidelines for decontamination (copy enclosed) are satisfied. Refer to NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", copy enclosed.

Specific concerns noted during our review of your application dated April 3, 1996, are mentioned below in the approximate order of their appearance on the "Checklist for Review of Applications for Broad-Scope Licenses".

1. Submit your ALARA program. You may commit to following Appendix G of Regulatory Guide 10.8, Revision 2, copy enclosed, or you may submit equivalent commitments. Also refer to 10 CFR 20.1101.

2. It should be noted that you have on file a Statement of Intent dated May 8, 1991 for decommissioning funding (copy enclosed) in the amount of $750,000 pursuant to 10 CFR 30.35, 40.36, and 70.25. Therefore, License Condition 24. on Amendment 22 will be replaced with a standard license condition similar to this one:

   > In addition to the possession limits in Item 8, the licensee shall further restrict the possession of unsealed licensed material or readily dispersible source material to quantities less than 10^5 times the applicable limits in Appendix B of 10 CFR PART 30, and 10 mCi of dispersible source material as specified in 10 CFR 30.35, 40.36, and 70.25.

   However, using this condition will require that the Statement of Intent be revised to cover $750,000 for byproduct material, $750,000 for special nuclear material, and $0 for dispersible source material, which results in a total of $1.5 million. This would necessitate submission of a revised Statement of Intent.

   You should review your license possession limits against the decommissioning criteria in 10 CFR 30.35, 40.36, and 70.25 to determine whether possession limits should be reduced or if the Statement of Intent should be increased.

   If you exceed the stated limits in the regulations for decommissioning financial assurance, it will be necessary for you to develop and submit a decommissioning funding plan. Refer to Item 1.7 of the broad-scope guide and to Regulatory Guide 3.65, copy enclosed.

   You should submit any revisions of your Statement of Intent or any funding plan in separate correspondence. However, revisions to the license possession limits should be described in your response to this letter.

3. Submit facility descriptions. Describe the areas currently in use and the types of authorized uses conducted at each location. Refer to Item 3, Page 10 of the broad-scope licensing guide.

4. Describe the authorized uses of licensed material. In particular, discuss any animal studies which you may perform. What types of animals are used? What materials may be administered? Are animals sacrificed immediately, or are they housed and studied? Refer to Items 5., 6., and of the broad-scope guide and to Item 12. of the review checklist.

5. Include an organizational chart depicting the management structure, reporting paths, and flow of authority, including the statement empowering the RSC. Describe the membership of the RSC, and specify who has voting rights. Include a charter for the RSC equivalent to that included as Appendix F of Regulatory Guide 10.8, Rev. 2. Also refer to Item 7 of the broad-scope guide and Item 7.2 of the review checklist.

6. With regard to the RSO, specify the number of hours per week this individual will be available to oversee the NRC licensed program. Specify provisions for contacting this person during emergencies or off-hours and provide a general description of his other obligations. State that the RSO will report directly to senior management, have ready access to all levels of the organization, and will have the authority to immediately terminate any activities that are found to be a threat to public health, safety, or property.

7. With regard to the Alternate RSO, as mentioned on page 3 of your application, indicate the minimum training requirements and the normal duties of this position. It should be noted that the Alternate RSO should have the same qualifications as the RSO, as this person may be called on to act in that capacity in the absence of the RSO.

8. Specify the minimum training and experience for your authorized users. Refer to Appendix I of the broad scope guide. Note that emergency procedures should be included in this training. Also refer to Item 8. of the review checklist. Supply a copy of the authorized user application form to be used by the RSO and RSC.

9. Describe your laboratory classification scheme based on radiotoxicity and activity, and describe the RSC review of the adequacy of new facilities and uses. Refer to Item 10.5 and Appendix K of the broad-scope guide, as well as Items 9. and 10.5 of the checklist.

10. Describe the surveys to be performed by the authorized users and by the RSO for each laboratory classification. Refer to Item 10.6 of the broad-scope guide and to Items 10.5 and 10.6 of the checklist.

11 Describe the types and numbers of survey and monitoring instruments available to your staff, and specify how they will be calibrated. Refer to Item 9. of the checklist and to Appendix B of Regulatory Guide 10.8, Rev.2.

12. Submit your emergency procedures, as they relate to licensed materials. Refer to Item 10.2.3 of the broad scope guide and to Item 10.2 of the review checklist. You should also describe the mechanism for notifying the NRC of emergencies as may be required by 10 CFR 20.2201, 20.2202, or 20.2203.

13. Either commit to following Appendix I of Regulatory Guide 10.8, Rev. 2, or specify prohibitions against unsafe practices which are listed in that document.

14. Specify that the RSO will maintain a continuous inventory of licensed materials. Submit new procedures, as necessary, to assist the RSO in maintaining this information. For example, describe the mechanism which will be used to inform the RSO of the receipt of licensed material. This is necessary to ensure proper training of personnel, laboratory surveillance, and waste disposal procedures. Refer to Item 10.3 of the broad-scope guide.

15. Submit a description of your bioassay programs. If such programs are not currently necessary, so state and specify the reasons for not implementing them at this time. Also, specify that a subsequent amendment request will be submitted if such programs become necessary in the future. Refer to Item 10.6.2 of the broad-scope guide and to Item 10.6 of the enclosed checklist.

16. As you indicated that you utilize the decay-in-storage method for disposal of licensed material, the following license condition will be added to your license upon renewal:

    The licensee is authorized to hold radioactive material with a physical half-life of less than 65 days for decay-in-storage before disposal in ordinary trash provided:

    A. Radioactive waste to be disposed of in this manner shall be held for decay a minimum of 10 half-lives.

    B. Before disposal as ordinary trash, byproduct material shall be surveyed at the container surface with the appropriate meter set on its most sensitive scale and with no interposed shielding to determine that its radioactivity cannot be distinguished from background. All radiation labels shall be removed or obliterated.

C. A record of each disposal permitted under this License Condition shall be retained for 3 years. The record must include the date of disposal, the date on which the byproduct material was placed in storage, the radionuclides disposed, the survey instrument used, the background dose rate, the dose rate measured at the surface of each waste container, and the name of the individual who performed the disposal.

If you wish to increase your decay-in-storage authorization to include licensed materials with half-lives greater than 65 days, you should so specify. It may be necessary to provide additional information as outlined in the enclosed NRC Information Notice 90-09. Also, refer to Policy and Guidance Directive 94-05, copy enclosed.

You should specify whether the standard condition will be adequate for your program. If not, supply the additional information as described above. Refer to Item 11. of the broad-scope guide and to Item 11. of the checklist.

17. Although your application indicated that the RSO is responsible for providing users the maximum quantities of radionuclides that may be disposed in the sanitary sewer system, it is not clear what mechanisms will be used to so inform users and to verify compliance. You should specify whether allowed waste disposal limits will be stipulated in the users' permits. Also, describe other mechanisms used to control waste disposals. Refer to Item 11.3 of the enclosed guide.

18. You should state how you have determined compliance with 40 CFR 61 Subpart I regarding air effluents. Refer to Draft Regulatory Guide DG-8016, and to Regulatory Guide 8.37, copies enclosed.

We will continue the review of your renewal request upon receipt of this information. Please reply in duplicate, and refer to Mail Control 571951.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Enclosures: As Stated

Docket: 030-06981
License: 27-05861-02
Control: 571951

bcc:

Docket File
WCFO Inspection File
LFDCB, T-9 E10
State of NV (License Only)

DOCUMENT NAME: G:\beth\571951

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
P.O. BOX 93478 • LAS VEGAS, NV 89193-3478

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OFFICE OF
RESEARCH AND DEVELOPMENT

April 3, 1996

Mr. Jim Montgomery
Radioactive Materials Safety Branch
U.S. Nuclear Regulatory Commission, Region V
1450 Maria Lane
Walnut Creek, CA 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981

Subject: NRC Material License Application Renewal Request

Dear Mr. Montgomery:

Enclosed for your review and approval is NRC Form 313 for our NRC material license application renewal request. Please note that we used Draft Regulatory Guide DG-0005 as the basis for preparing this renewal application.

If you have any questions, or in any other way need my assistance, please call me (702-798-2525)

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director, Characterization Research Division

Enclosure

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NRC FORM 313 (6-93)
10 CFR 30, 32, 33
34, 35, 36, 39 and 40

U. S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIAL LICENSE

APPROVED BY OMB: NO. 3150-0120
EXPIRES 6-30-96

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 9 HOURS. SUBMITTAL OF THE APPLICATION IS NECESSARY TO DETERMINE THAT THE APPLICANT IS QUALIFIED AND THAT ADEQUATE PROCEDURES EXIST TO PROTECT THE PUBLIC HEALTH AND SAFETY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0120), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

LICENSING ASSISTANT SECTION
NUCLEAR MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION II
101 MARIETTA STREET, NW, SUITE 2900
ATLANTA, GA 30323-0199

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137-5927

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TX 76011-8064

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

RADIOACTIVE MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION V
1450 MARIA LANE
WALNUT CREEK, CA 94596-5368

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S.NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*
   - [ ] A. NEW LICENSE
   - [ ] B. AMENDMENT TO LICENSE NUMBER _____
   - [X] C. RENEWAL OF LICENSE NUMBER 27-05861-02

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip code)*
   US Environmental Protection Agency
   Characterization Research Division
   PO Box 93478
   Las Vegas, NV 89193-3478

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED
   US Environmental Protection Agency
   National Exposure Research Laboratory
   Characterization Research Division
   944 East Harmon Avenue
   Las Vegas, NV

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION
   Stephen H. Pia, Chairman
   Radiation Safety Committee

   TELEPHONE NUMBER
   702-798-2102

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5.	RADIOACTIVE MATERIAL. a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.	6.	PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7.	INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.	8.	TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9.	FACILITIES AND EQUIPMENT.	10.	RADIATION SAFETY PROGRAM.
11.	WASTE MANAGEMENT.	12.	LICENSEE FEES *(See 10 CFR 170 and Section 170.31)* FEE CATEGORY / AMOUNT ENCLOSED $

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39 AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER – TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Wayne N. Marchant, Director	Wayne N Marchant	4-3-96

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED $	CHECK NUMBER	COMMENTS

APPROVED BY	DATE

PRINTED ON RECYCLED PAPER

Item 5. Radioactive material: a) element and mass number; b) chemical and/or physical form; and c) maximum amount which will be possessed at any one time.

Radioactive materials and sources authorized in the license (Nov. 28, 1995) are current.

Item 6. Purposes for which licensed material will be used

There are no changes for purposes for which licensed material will be used from those currently authorized.

Item 7. Individuals responsible for the Radiation Safety Program and their training experience

SENIOR MANAGEMENT

The Director of the U. S. Environmental Protection Agency's National Exposure Research Laboratory, Characterization Research Division, Las Vegas (CRD-LV) has the responsibility for the organization and operation of the facility's radiation safety program. The radiation safety committee (RSC) has been delegated the responsibility to recommend policies and develop and monitor radiation safety practices, conformance to which is obligatory for all authorized users and workers of CRD-LV and collocated units subject to the provisions of this license. The radiation safety officer (RSO) has been delegated the responsibility of the day to day operation of the facilities radiation safety program and the authority to communicate with all levels of management consistent with this authority

While the RSC and RSO have broad authority to operate independently they are required to resolve all safety and regulatory issues at the lowest level of management.

There are four working elements in the radiation safety program classified by the following titles: (1) Authorized users are employees approved by the RSC to use and direct tasks involving the use of radioactive materials, (2) the RSO, appointed by the licensee's Director and confirmed by the RSC, is a technical advisor to the user and all levels of management, (3) the RSC which develops and reviews safety practices, monitors compliance to the program and arbitrates all disagreements and disputes, and (4) senior management which approves the action of the committee and can direct the committee to focus on problem areas of the radiation safety program.

The radiation safety committee has been given the authority to recommend policies and implement, through its authorized users, all radiation safety practices. The RSO is an advisor to management, an officer of the RSC, an advisor to all users under this license regarding the requirements of the license and other policies which may from time to time be instituted.

Management enforces and ensures that the policies of the RSC are implemented by the users

in two ways. The RSO periodically audits each users operation and reviews any findings with the user and the users supervisor. This is the primary mechanism ensuring safe operation and conformance to applicable regulation.

Additionally, any individual or member of the RSC, may at any time bring to management's attention any and all instances of noncompliance that the individual feels should be addressed only by the senior management of the facility. This policy is the fail safe of the radiation safety program of this facility. The process is to notify management of the concern with a copy to the chair of the RSC and the to the RSO. Management then has the responsibility to develop and implement corrective action.

Additionally, senior management is apprised of the programs status by quarterly or more frequent meetings of the RSC. Management is committed to a proactive safety program in which any user of licensed material has access and recourse to actions which ensure quick and definitive resolution of identified safety or regulatory concerns.

RADIATION SAFETY COMMITTEE

The RSC has the responsibility to recommended policies, develop and implement practices consistent with existing regulation and safe and prudent laboratory or field operations. In particular, the RSC has established procedures for procurement of radioactive materials, use of these materials in laboratory or field procedures, sanctions by review and vote the adequacy of safety practices for the use of radioactive materials and has developed and implemented a radiation safety program. The RSC has the authority to define the duties and responsibilities of the RSO consistent with Agency policy and applicable regulation and to amend the radiation safety program to reflect current program needs and any changes in applicable regulations.

The RSC is composed of the authorized users, chair, RSO, representative(s) of senior management or a senior management delegate. A quorum for a regular meeting is one third of the members including the management representative or management appointee, the RSO and the RSC chair. In the absence of the chair one of the committee members present shall be appointed to conduct the meeting. Members not present may vote by proxy on matters on the agenda via electronic mail or in writing to the chair or by assigning the proxy to another member.

The RSC meets at least quarterly or more frequently at the discretion of the facility's Director, RSO or Chair.

The Chair of the RSC is Stephen H. Pia, the RSO is Loyd D. Carroll, and the management representative is John M. Moore Deputy Director of the facility.

RADIATION SAFETY OFFICER

The RSO is responsible for the day to day oversight of the facility's radiation safety program

and communicating to and working with all levels of management and the RSC regarding the implementation and compliance status of the radiation safety program. The compliance status of the program is reported to the RSC at all regular meetings. Additionally, the RSO is available for advice or assistance to any individual during regular duty hour and during off duty hours in case of emergency. The alternate RSO assumes these duties when the RSO is unavailable.

The specific duties of the RSO are consistent with those listed in appendix H of the guidance document (Oct. 94 draft) with the following exceptions identified by the line number in that appendix:

3. This facility has no requirement for specialized air filtration.

4. Inspection and monitoring of incoming shipments of radioactive can be done by the user if the RSO is unavailable to satisfy NRC time requirements.

6. Personnel dosimetry is provided, as needed in compliance with 10CFR 20.1502, through the dosimetry program and coordinated through the RSO.

7. The RSO monitors compliance to the disposal guidelines established by the RSC for disposal via the sanitary system and is not directly responsible for routine disposal by this route unless the RSO accepts this responsibility upon request of a user.

9. The RSO is only responsible for storing radioactive materials accepted upon request by a user.

Item 8. Training for individuals working in or frequenting restricted areas

RADIATION SAFETY TRAINING

New employee, prior to working with radioactive materials or equipment that produces ionizing radiation for the first time, receive radiation safety training commensurate with their duties, any additional training required by the RSC, or if subject to the requirements in 10 CFR 19.12. Training is may be conducted by the RSO or the authorized user.

Female radiation workers are required to review, USNRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" with Appendices A and B, and informed of their rights about declaring a pregnancy and are required to contact the RSO when a pregnancy is declared.

Other individuals who may frequent or work in an area where sources of ionizing radiation are used or stored, receive radiation safety training commensurate with their duties.

Radiation workers receive training in the safe use and handling of radioactive materials and

such specialized instruction as required by the authorized user under whose radiation authorization they work.

All users receive annual radiation safety training conducted by the RSO or an authorized user.

Training records are maintained by the RSO.

Item 9. Facilities and equipment

The information for our facilities and equipment previously submitted in our NRC material license renewal application in January, 1989, is the same, with the exception for the following two changes.

1. Add the EPA Government Parking Compound which was inadvertently omitted with our previous NRC license renewal application in January, 1989. This area is located adjacent to and southwest from La Plaza building C at 4220 South Maryland Parkway. This is a secured, fenced area used by ORIA personnel for parking of EPA vehicles containing low-level or exempt quantities of radioactive materials, used as calibration standards for field equipment or radiation survey meters in the vehicles. During duty hours, the northern entrance gate remains open and unattended vehicles in the compound are secured and locked.

2. Delete the Special Use Isotope Facility (Hot Lab) in room 46 of the Quality Assurance Laboratory (QAL) building. All radioactive materials were removed from this room and a close-out radiation protection survey was conducted by the RSO in the latter part of 1992.

Need complete survey

Areas for the use and storage of radioactive materials and other sources of ionizing radiation are approved by the Radiation Safety Committee and stipulated in the users authorization.

Item 10. Radiation Safety Program.

PREVIOUS LICENSES

This application is for renewal of the facilities current license number 27-05861-02 and all amendments as of November 28, 1995.

ADMINISTRATIVE PROCEDURES

Control of Procurement and Use

Procurement requests for radionuclides or devices containing sources are forwarded by the user or the purchasing agent to the RSO for review. The RSO assigns an internal tracking

number for each separate item of the request and confirms that the quantity ordered plus the quantity on hand will not exceed the maximum licensed quantities. When the review is completed the RSO approves the request and forwards it to the purchasing agent.

Authorized use of licensed materials are described in each users authorization. Proposed uses beyond the scope of an existing authorization require review and approval of the RSC. Interim amendments to an authorization may be granted by the RSC if the proposed use is consistent with the current authorization, the change is adequately defined and relevant safety concerns addressed. After review and concurrence by the RSO, RSC chair, and other users if required to provide technical review, the RSC chair approves the interim authorization pending final approval of the RSC.

Emergency Procedures

The scope and use of licensed materials at this facility preclude any emergency or threat to the public due to these materials. The facility has a general emergency response plan outlining actions to be taken in the event of fire, bomb threat, civil disturbance and natural threats (earthquakes, severe weather).

Licensed material reported lost or missing are investigated by the RSO. The RSO prepares a report which is reviewed by the user, the users supervisor, the RSC chair and the RSC. The report describes the circumstances and recommends corrective action.

Reports to NRC pursuant to Pt. 20 requirements

Operating and Handling Procedures

The facility has an a radiation safety manual which provides general standards for laboratory and prudent practices. To minimize even incidental ingestion of radionuclides, disposable gloves and protective clothing are worn during all procedures in which radionuclides are in a dispersible form. Tweezers or disposal gloves are used when handling samples and standards on planchets and plated disks where incidental contamination would most likely occur.

Each experimental or test method has a section addressing safety issues the procedure may entail. In general, there are no unusual safety considerations due to dispersible radionuclides used at this facility because of the very low concentration used in environmental radiochemistry procedures. General safety practices and engineering controls provide ample safeguards against incidental contamination or uncontrolled exposure.

The primary safeguard against contamination is adherence to procedural discipline. Surveys of the work area conducted by the user on a day of use basis after the use of dispersible radionuclides that equal or exceed those limits listed in schedule B, 10CFR 30.71. Survey meters sensitive to alpha, beta and gamma are available to the user for these surveys. Bench tops, trays, sinks, fume hoods, and other areas where radionuclides were used or likely present in samples are surveyed and a record kept in a log book or other record. Swipe surveys of laboratories are

conducted at least quarterly by the RSO/user to detect contamination. Sealed sources requiring leak tests are swipe surveyed at least every six months or more frequently as required.

INVENTORY AND ACCOUNTABILITY

Inventories of all radionuclides and sources are conducted by the authorized users at least semiannually and are forwarded to the RSO who keeps a master inventory of all radioactive material at the facility. The master inventory reflects the quantity on hand and type of radioactive material or source.

AUDITS AND APPRAISALS

technician training?

Audits of the program are conducted at least annually by the RSO and other groups as may from time to time be appointed by the RSC or the facility's Director. The audit includes a review of user authorizations, verification of compliance to facility and EPA policies, timeliness of inventories, completion of required area and source swipe surveys, practices for disposal of radionuclides and sealed sources, and other aspects of the program to verify that the provisions of the radiation safety program are followed. The audits are intended to identify any shortcomings of the program and identify to senior management and the RSC, procedures or practices which may require modification, amendment, development or deletion.

Audit findings and recommendations for corrective action are reviewed by the user and the users supervisor, senior management, and the RSC.

documentation
follow-up action?

EVALUATION OF PROPOSED USES AND USERS

The RSO has the responsibility to review the proposal with the user requesting the authorization. This level of review is usually sufficient to ensure all issues have been addressed. However, the RSO may direct the proposal to other users for review and comment. The RSC reviews the proposal and any comments, then approves or denies the application.

Review of the authorization request includes, but is not limited to, the user's provisions regarding work area surveys, dosimetry requirements, proposed use of material, radionuclides, sources or radiation producing devices, limits, other information related to use, and training which are general components of every authorization.

The nature of work at this facility involves laboratory and field measurement of environmental radioactivity. Laboratory procedures to minimize background and control incidental contamination of samples, have as a consequence the added dimension of providing for employees and the public a working environment entirely free of potential exposure to radioactivity of regulatory concern. Engineering controls ensure minimal exposure to radiation from sealed sources or other sources of ionizing radiation.

General laboratory practices are sufficient to safely use dispersible radionuclides in all current practices and procedures. No special environmental equipment are required beyond those found in the facility's well maintained laboratories.

EXPOSURE CONTROL AND MONITORING

Laboratory procedures require the use of protective gloves and clothing when handling dispersible radionuclides. This practice virtually eliminates the possibility of incidental contamination. All work with dispersible (solutions or dried materials) radionuclides is conducted in trays or on work surfaces covered with a polymer barrier or covered with polymer backed absorbent paper. These practices are the primary safeguards against contamination or accidental exposure.

After dispersible radionuclides are used at levels equal to or greater than those listed in schedule B of 10 CFR 30.71, the user is required to survey the work area with a survey meter sensitive to the particle or photon of the radionuclide(s). The survey includes the trays, bench tops, hood, hot plates, sinks and other laboratory equipment involved in the procedure. This is the primary means of contamination monitoring.

At least quarterly, swipe surveys of laboratory work areas are conducted by the RSO/user to verify control of contamination.

Laboratories where dispersible radionuclides are used are classified as Type C and type B facilities based on the general criteria for radiotoxicity and quantity of the IAEA safety standard in the guidance document.

The facility's dosimetry program is certified by DOELAP a Department of Energy accreditation program. Dosimetry TLDs are issued in conformance with 10CFR 20.1502. The TLD's are exchanged and processed for dose equivalent quarterly. Annually, each NRC individual monitored by the dosimetry program and requiring a report in conformance with NRC regulation receives a summary report of their exposure. Results are reviewed by the facility's dosimetry manager and the RSO.

Item 11. Waste Management

WASTE DISPOSAL

The RSO is responsible for oversight of all radioactive waste disposed in the sanitary system and radioactive wastes going to commercial disposers according to procedures approved by the RSC. The RSO also has the responsibility of providing to the authorized users the maximum quantities of the radionuclides authorized in the license that may be disposed via the sanitary system.

The RSO in coordination with the facility's Safety Health and Environmental Manager (SHEM) are responsible for the off-site disposal of sources, devices producing ionizing radiation, radioactive wastes, and mixed radioactive wastes containing RCRA hazardous components.

Users maintain a record of radioactive wastes disposed via the sanitary system in a log book or other record for that purpose. This record is reviewed by the RSO and other audit teams.

It is this facility's policy that bulk liquid scintillation waste be sent to commercial disposers. Prior to disposal of tritium or carbon 14 liquid scintillation waste the user must submit to the RSO, verification that the level of either of these nuclides is ≤ 0.05 uCi per gram. Wastes in this category are transferred by the user to the SHEM for disposal.

Radioactive waste containing RCRA hazardous components, as defined in 40 CFR Part 261, are characterized by the user as to the kind and quantity of radionuclides and hazardous components present. The RSO in coordination with the SHEM will arrange for off-site disposal.

Additional Waste Management and Disposal Guidelines

The management or disposal of radioactive waste containing non-hazardous materials by the following practices are authorized by the RSC at this time:

No RSO survey?

a. Decay in storage. Short-lived radionuclides are held for at least ten half-lives. Analytical results are submitted to the RSO to verify that background radiation levels are not exceeded and all radiation labels, symbols, or the words "radioactive materials," are removed or defaced and the waste is transferred to the SHEM for disposed as non-radioactive waste.

b. The release of soluble and readily dispersible biological materials into the sanitary sewerage system. The quantities released will not exceed the average monthly concentrations specified in Table 3, Appendix B, 10 CFR 20.1001- 20.2401. The total quantity released in a year will not exceed 5 curies (185 GBq) of Hydrogen-3, 1 curie (37 GBq) of Carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

c. The disposal of specific wastes as if the waste is nonradioactive. Authorized for disposal is 0.05 microcuries (1.85 kBq), or less, of Hydrogen-3 or Carbon-14 per gram of medium used for liquid scintillation counting or animal tissue, averaged over the weight of the entire animal.

d. Radioactive solutions may be precipitated or evaporated to dryness and then treated as solid waste.

e. The transfer of waste to a licensed facility authorized to receive, store, transfer and dispose of the waste. The shipment and transportation of radioactive waste is coordinated by the RSO and the SHEM in accordance with applicable parts in 10 CFR, DOT regulations and, 49 CFR Parts 171 through 180.

Radioactive waste are segregated from non-radioactive waste to ensure that the radioactive waste on-hand at the facility is kept to a minimum. All containers of radioactive waste are labeled and identified as required.

Shipments of radioactive waste are contracted to an authorized and licensed broker for the packaging, transportation and ultimate disposal of the waste.

Item 12. Licensee Fees (not required).

57/951

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
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cc:
B. Prange
Frank W. - MB WCFO
LLH
RAS
C. Hackney
- RA → D/RA

February 1, 1995

FEB - 6 1995

Excellent job in 1/20 Ltr. to EPA!

D. Acton WCFO to respond

Mr. Samuel J. Collins
Director, Division of Radiation
Safety and Safeguards
U.S. Nuclear Regulatory Commission, Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

Reference: License No. 27-05861-02
Docket No. 030-06981

Dear Mr. Collins:

Thank you for your January 20, 1995 reply to my November 28, 1994 inquiries. Your letter was excellent, and could serve as a model for effective communication. I appreciate the thoughtful and helpful responses to my questions.

Based on the information in your letter, I ask to withdraw our pending license application. I would like to submit a replacement application that will incorporate the information and suggestions you offered. We will do so as quickly as possible.

If you have any questions, or if this letter is not sufficient to enable you to return our pending application, I would appreciate an early notification. I would welcome a telephone call at (702) 798-2525.

Sincerely yours,

Wayne N. Marchant

Wayne N. Marchant
Director

cc: Donald Daigler, EMSL-LV/RSD
Loyd Carroll, EMSL-LV/RSD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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RW WCFO
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cc:
B. Prange - MB WCFO
Frank W.
LLH
RAS
C. Hackney
_ RA → D/RA

February 1, 1995

Mr. Samuel J. Collins
Director, Division of Radiation
Safety and Safeguards
U.S. Nuclear Regulatory Commission, Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

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Sincerely yours,

Wayne N. Marchant

Wayne N. Marchant
Director

cc: Donald Daigler, EMSL-LV/RSD
Loyd Carroll, EMSL-LV/RSD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EXPOSURE RESEARCH LABORATORY
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OFFICE OF
RESEARCH AND DEVELOPMENT

February 15, 1996

Ms. Beth A. Prange
Senior Health Physicist, Licensing
Materials Branch
United States Nuclear Regulatory Commission - Region IV
1450 Maria Lane
Walnut Creek, CA 94596-5368

Dear Ms. Prange:

In a telephone conversation last fall you asked about the progress of our pending license application. I told you then that we would submit our new application by December 1995. Since our conversation, however, many unforeseeable developments have delayed completion of the application. I'm sure you know we were on furlough for a total of approximately one work-month. This has delayed our work on the application by more than a month, owing to the indirect effects of stopping work twice and re-starting. Our situation in EPA has been further exacerbated by the continuing uncertainty about our budget. This has necessitated repeated short-term planning and budgeting exercises that have distracted us both from our research and from completing the license application.

I conferred with the Chairman of our Radiation Safety Committee this morning. He assured me that he and his colleagues will complete work on the application so we can submit it during the first week in April.

I regret the delay, but I hope it is acceptable under the unprecedented circumstances. If you have any questions or comments, please feel free to call me at (702) 798-2525. If you have technical comments or questions, I suggest you talk directly to Stephen (Steve) Pia, Chairman of the Radiation Safety Committee at (702) 798-2102.

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director
Characterization Research Division

cc: Steve Pia
Loyd Carroll

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV

Walnut Creek Field Office
1450 Maria Lane
Walnut Creek, California 94596-5368

FEB 1 5 1995

U.S. Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Laboratory
ATTN: Wayne N. Marchant
Director
P.O. Box 93478
Las Vegas, NV 89193-3478

SUBJECT: LETTER DATED FEBRUARY 1, 1995

This refers to your letter dated February 1, 1995, in which you informed us of your intent to withdraw the current renewal request and to resubmit a new application.

We have no objections to this approach; however, we need to retain the original copy of the previous submittal to demonstrate that your previous renewal request was filed in a timely manner (i.e., before the expiration date stated on the license, February 28, 1994). Without a timely renewal request, the license would expire. A complete copy of your application dated February 11, 1994 is enclosed to assist you in drafting the resubmittal.

We will also retain your most recent letter in the file, and we will wait for the renewal request to be replaced by the resubmittal.

If you have questions concerning these matters, I can be contacted at (510) 975-0250.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Materials Branch

Docket: 030-06981
License: 27-05861-02
Control: 571951

Enclosures: As stated

bcc:

Docket File
WCFO Inspection File
LFDCB, T-9 E10

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76011

January 20, 1995

U. S. Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Laboratory
ATTN: Wayne N. Marchant
Director
P.O. Box 93478
Las Vegas, NV 89193-3478

SUBJECT: LETTER DATED NOVEMBER 28, 1994

This refers to your letter dated November 28, 1994, in which you raised a number of questions regarding your NRC license and the NRC's new guidance concerning applications for broad-scope licenses. NRC Region IV staff has reviewed your correspondence and has prepared responses to the questions raised in your letter as discussed below.

In responding to your request for assistance, I wish to emphasize that NRC staff members are available to respond to questions regarding regulatory requirements; however, our license reviewers and inspectors are prohibited from consulting with licensees or providing recommendations for program improvements beyond the guidance provided in NRC publications or during NRC-sponsored workshops. Therefore, we would not be able to make an inspector or license reviewer available to you for participation in a Total Quality Management exercise as suggested in your letter. However, if you so desire, a pre-licensing visit can be scheduled after your renewal application is reviewed and a draft license is prepared. The purpose of the visit would be to describe the requirements of the license, as drafted by the reviewer.

We note that several questions raised in your letter involve existing requirements incorporated in your license by reference. License renewal provides an opportunity for a licensee to modify certain commitments made during previous license applications and amendment requests. In light of your concerns, you may elect to resubmit a new license application in its entirety and withdraw the current renewal application. Submittal of a new application drafted with the new guidance and your concerns in mind may improve the license and resolve your stated concerns.

The new guidance (Draft Regulatory Guide DG-0005), which was drafted for use by all Type A and B broad-scope programs, was issued to assist licensees in determining what information should be submitted to support a request for licensing action, particularly a license application. You should be aware that the license application is referenced in the final license condition and therefore becomes a legally-binding document. The new guidance was meant to explain what commitments must be specifically described in the application and what types of information could be described in more general terms, thereby giving you the latitude to adjust your program to suit its changing needs without requiring further licensing actions.

In response to your specific questions, we offer the following comments. The numbered paragraphs below correspond to the questions raised in your letter.

1. The NRC's radiation safety standards are established in Title 10 of the Code of Federal Regulations. It is the responsibility of each licensee to determine how they will achieve compliance with the regulations. Regulatory guides, licensing guides, NUREG documents, staff position papers, etc. have been written to assist staff members and licensee representatives in meeting this goal. However, guidance provided in the latter publications does not constitute a regulatory requirement. Different procedures may be proposed, reviewed, and approved in the licensing process.

   It should be noted that the new broad-scope licensing guidance incorporates the concept that your radiation safety manual should not be incorporated by reference in the final condition of your license. Thus, you will be able to make changes in the procedures contained in your radiation safety manual without necessitating amendment of your license. Commitments which must be specified in your application are discussed in detail in the guide. Also, refer to footnote 5 on page G-2 of the broad scope guide, which discusses specifying several types of changes which may be made without notifying the NRC if you so desire. Your application for renewal should specify the types of changes that you would like to make, under the approval of the Radiation Safety Committee (RSC), if you wish to have that type of flexibility in your program.

2. Item 7.2 and Appendix G of the broad scope guide discuss the function and duties of the RSC. The RSC should meet as often as necessary, but not less than quarterly. If there are many new authorizations or many new user qualification forms to review, frequent meetings may be necessary. Most broad-scope programs are able to function adequately with quarterly meeting schedules.

   You should also note that commitments made in response to Notices of Violation are also binding on licensees. In a letter dated September 29, 1993, (copy enclosed) you stated that senior management personnel would hold monthly staff meetings with key members of the RSC. This commitment was made in response to a Notice of Violation issued by NRC on August 4, 1993. If these meetings are becoming burdensome, this policy could be revised by specifically addressing this issue during the license renewal process.

3. RSC meeting minutes must be documented in writing and retained for inspection purposes. The minutes should document the reviews of new users or uses, audits, and follow-up actions taken in regard to problems at your facility. Since they are very important documents, the minutes may be concise but should contain adequate detail for the reader to determine what was discussed, recommended or decided by the committee. These records will be used by the inspector to help determine how well the RSC is carrying out its duties. The format and length will vary from

one meeting to another depending on the number of items reviewed and the number of problems the RSC had to resolve.

4. You should be aware of the major issues discussed at the meetings, but your approval of the RSC minutes is not an NRC requirement.

5. The NRC does not recommend that the radiation safety officer (RSO) and the RSC Chairperson be the same individual (refer to page 24 of the broad scope guide). The RSO must be a member of the RSC and is expected to function as a valuable technical resource to the RSC because of his or her experience and training. The RSC should have a Chairperson with strong leadership skills who can work closely and effectively with the RSO.

   Normally, we expect the RSC Chairperson to be endorsed by management and empowered to make decisions on management's behalf as they relate to radiation safety. The Chairperson is named on the license application, and an amendment is needed if there is a change. Other members of the RSC may be listed by title and qualifications.

6. NRC expects strong management commitment, a strong RSC and an experienced RSO who is provided adequate time to perform all duties of his or her position. For most broad scope programs, this involves a full-time commitment by the RSO. If the RSO is supported by a health-physics group which carries out some of his or her duties, a part-time commitment could be adequate. Your needs for a full-time RSO will be dependent on the scope and complexity of your program. A static program with few laboratories and few new work-authorizations or users may warrant consideration of a part-time RSO.

   Depending on the amount of change or expansion you anticipate in your licensed activities, you should be able to forecast your health-physics support needs. If your program will be static and your RSO is supported by other staff members or a private consultant, you may be able to achieve compliance with a collateral-duty RSO. This is a management decision.

   If future inspections indicate that the course of action you chose did not achieve the desired effect, then you will need to examine options to strengthen the radiation safety program. On the other hand, you may decide that you do not have the resources to support a broad-scope license. In this case, you could change the license to a specific license of limited scope. With this type of license, authorized users and uses are stated on the license, and changes to the program necessitate amendments. Specified procedures are normally submitted with the license application. It is our understanding that this type of program will not currently satisfy your needs due to obligations to perform sampling analysis under emergency situations.

In addition to the specific issues addressed in your questions, let me also offer some comments regarding other aspects of a broad-scope radiation safety program. A key element of a strong radiation safety program is an effective audit program conducted by the RSO and RSC. Implementation of an effective audit program may have a significant positive impact on your program overall and may result in substantial improvement in your performance from a regulatory perspective. Radiation safety audits are described in Items 10.4.1 and 10.4.2 of the new guide. Participation by management and one or more members of the RSC during laboratory audits conducted by the RSO has been extremely beneficial to many licensees. It promotes communication and sends a message to the users that management supports the RSO and considers radiation safety to be important. NRC views audit programs as a fundamental component of a strong broad-scope radiation safety program.

I hope that this letter is fully responsive to the concerns you expressed in your most recent letter to us. If your stated concerns were not fully resolved in this letter, please contact Ms. Linda Howell of my staff at (817) 860-8213.

Sincerely,

Samuel J. Collins, Director
Division of Radiation Safety
and Safeguards

Docket: 030-06981
License: 27-05861-02

Enclosures: As stated

bcc:
DMB - Original (IE-07)
LJCallan
DWeiss, OC/LFDCB (T-9E10)
DBSpitzberg
LLHowell
FAWenslawski
BPrange
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RECEIVED NRC
'93 SEP 34 A 10:30
REGION V

September 29, 1993

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

SUBJECT: Reply to a Notice of Violation

REFERENCE: Docket No. 030-06981
License No. 27-05861-02

Dear Sir:

As requested by a phone call on September 20, 1993, from the NRC Region V auditor who performed an inspection of this facility during July 6-7, 1993, I am providing additional information for those actions initiated to improve management's effectiveness and oversight of our licensed program to prevent future violations.

Senior management personnel will hold monthly meetings with the Radiation Safety Officer, Chairperson of the Radiation Safety Committee, and the Directors of the two major groups of personnel who use radioactive materials, the Office of Radiation and Indoor Air (ORIA) and Nuclear Radiation Assessment Division (NRD). Senior management will also meet with the Chairperson of the Radiation Safety Committee and the Radiation Safety Officer prior to each Radiation Safety Committee meeting or at any other time as needed. The Radiation Safety Officer will periodically perform inspections of usage areas and provide his findings to the Radiation Safety Committee.

These actions will ensure that senior management and subordinate managers are knowledgeable in safety issues and potential problems which may warrant our intervention to ensure immediate resolution for compliance with NRC requirements.

If you require additional information, please call me (702-798-2525) or our Radiation Safety personnel (702-798-2313/2390).

Sincerely yours,

T. Dwight Pearson
for Wayne N. Marchant
Director

cc:
Region V office, Attention: Mr. David Skov

9310050[illegible]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
(702/798-2100 - FTS 545-2100)

NOV 28

U.S. Nuclear Regulatory Commission Region IV
Nuclear Materials and Licensing Branch
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011

Reference: License No. 27-05861-02
Docket No. 030-06981

To Whom It May Concern:

Radiation science is a very important part of our laboratory mission. I use the term in a broad sense, to include at least such activities as monitoring exposure around the U.S. Department of Energy's Nevada Test Site (NTS), radiochemical analysis, quality assurance, scientific support for regulation of radon in drinking water, and the like. We have a Type A Broad Scope license that covers our activities under the purview of the NRC. And, to provide effective protection for our employees and the surrounding environment, we operate a radiation safety program, which includes a collateral-duty Radiation Safety Officer (RSO) and a Radiation Safety Committee (RSC).

Despite our intention and conscientious efforts to be perfect, your inspections of our facilities and programs have identified weaknesses. I am very interested in improving our radiation safety program to eliminate, or at least greatly reduce the potential for such weaknesses. One impediment to success in this area is resistance by workers to a safety program that, rightly or wrongly, they perceive to be onerous--too restrictive, too time-consuming, too paperwork intensive, or otherwise burdensome.

I plan to use a "Total Quality Management," (TQM) approach to identify opportunities to improve our radiation safety program. Before I begin, however, I need to know how much freedom I have to tailor a safety program to the unique features of our laboratory and mission. From discussions with some of my staff, and from reading a draft of Regulatory Guide DG-0005, I conclude that I have considerable flexibility. I am writing to confirm that, and to ask your help with some specific questions. Rather than risk interpreting the *Code of Federal Regulations* incorrectly, I am soliciting interpretations from you--the experts who both write the regulations and oversee their application. I see two possible ways for you to help: (1) I would appreciate your answers to the following questions: and (2) I would welcome an NRC staff member's coming to the laboratory in person, either to discuss specific questions, or to participate in a TQM exercise.

1. One staff member told me that the NRC does not prescribe radiation safety standards, but accepts the standards that each site (laboratory) specifies in its radiation safety manual (or equivalent). This seems to agree with the Guide DG-0005. Is this correct?

2. Our RSC currently holds both monthly and quarterly meetings, for a total of 15 meetings annually. (That is, in months that mark the end of quarters, the RSC meets *twice*.) This practice pre-dates my assignment as Laboratory Director. It seems excessive. The draft of DG-0005, in Appendix G, states that meetings should take place at least on a quarterly basis. If fewer meetings than we now hold would be acceptable, can I change the schedule? Must I submit an amended license application to do so, or can I revise the schedule and merely notify you by letter of the change?

3. What documentation is required for safety committee meetings? Verbatim transcripts? Summaries only? Our RSC meeting minutes often run to tens of pages, which consume considerable time to prepare, and a commensurate amount of time to review.

4. Related to (3), preceding, our RSO submits minutes of the RSC meetings with an "Approval" block for my signature as Laboratory Director. Is my approval an NRC requirement? What does it signify? What could it possibly mean if I did *not* approve the minutes?

5. Also related to RSC meetings, who must conduct them? Currently our RSC is chaired by an independent chairperson--not the RSO. Must it be the RSO? My reading of DG-0005 is that this is a matter for the RSC to determine, and that the RSO is to be a resource for the RSC (rather than direct it or dictate to it). Is this correct?

6. Draft Guide DG-0005 states that "Generally, the NRC staff does not consider the use of consultants or part-time RSOs acceptable for broad scope programs" (page: 16). But the EPA, like most Federal agencies today, is under severe hiring constraints. Currently we are not even permitted to fill positions vacated by retirement or other separations. We don't have the luxury of committing a full-time-equivalent to RSO duties. Our RSO is not encumbered by other radiation-related responsibilities, such as chairing the RSC (see number (5), above). Isn't the real issue whether the safety program meets its objectives? Can we satisfy NRC requirements with, for example, a half-time, collateral duty RSO?

I regard it as very important to settle these radiation safety issues quickly. I would greatly appreciate an early response. If you want to discuss my questions, I would welcome a telephone call at (702) 798-2525.

Sincerely yours,

Wayne N. Marchant

Wayne N. Marchant
Director

DEC
REGION IV

cc: Paul Weeden, Radiation Sciences Div.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION V

1450 MARIA LANE
WALNUT CREEK, CALIFORNIA 94596-5368

MAR - 7 1994

Docket No.: 030-06981
License No.: 27-05861-02
Control No.: 571951

Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Lab
P.O. Box 93478
Las Vegas, NV 89193-3478

Attention: Wayne M. Marchant
Director

SUBJECT: LICENSE RENEWAL APPLICATION

This is to acknowledge receipt of your application for renewal of the materials license identified above. Your application is deemed timely filed, and accordingly, the license will not expire until final action has been taken by this office.

Any correspondence regarding this renewal application should reference the control number specified above and your license number.

Sincerely,

Beth A. Prange

Beth A. Prange
Sr. Health Physicist (Licensing)
Radioactive Materials Safety Branch

Distribution

Original and 1 copy of license to licensee
bcc w/original concurrence, copy of license and original correspondence:
License docket folder
bcc w/copy of license and correspondence:
Inspection folder
bcc w/correspondence and 2 copies of license:
Rita Messier, LFDCB, MNBB 4503
License only:
State of NV

BAP
BPrange
3/7/94 / /

REQUEST COPY YES __ NO ✓	REQUEST COPY YES __ NO __	REQUEST COPY YES __ NO __	REQUEST COPY YES __ NO __
SEND TO DCS YES __ NO__	SEND TO PDR YES__ NO*__		

* Please indicate which documents should **not** be sent to PDR. Refer to RV 0502-A8.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL MONITORING SYSTEMS LABORATORY-LAS VEGAS
P.O. BOX 93478
LAS VEGAS, NEVADA 89193-3478
(702/798-2100 - FTS 545-2100)

RECEIVED
NRC
REGION V
94 FEB 17 AM 9:52

February 11, 1994

U. S. Nuclear Regulatory Commission, Region V
Radioactive Materials Safety Branch
Attention: Mr. Jim Montgomery
1450 Maria Lane
Walnut Creek, California 94596-5368

Reference: License No. 27-05861-02
Docket No. 030-06981

Subject: NRC Material License Application Renewal Request

Dear Mr. Montgomery:

Attached for your review and approval is NRC Form 313 for our NRC material license application renewal request. Please note that this facility's approved Radiation Safety Manual, dated February 1994, was rewritten to comply with the new 10 CFR Part 20 requirements and supersedes the previous manual dated December, 1988.

If you need my assistance, please call me (702-798-2525).

Sincerely,

Wayne N. Marchant

Wayne N. Marchant
Director

Attachment

571951

Item 5. Radioactive material: a) element and mass number; b) chemical and/or physical form; and c) maximum amount which will be possessed at any one time.

With one exception, there are no changes in the radionuclides, forms and amounts currently authorized in our NRC License Amendment #18. Please delete Item 6-9AA (Pu-239, sealed or plated sources, not to exceed 5 uCi per source and 100 uCi total), which was previously requested by our letters dated July 27 (page 4, subparagraph f) and November 12, 1993 (page 2, subparagraph d). This radionuclide, form, maximum amount and its usage is authorized under Item 6-9J.

Item 6. Purposes for which licensed material will be used.

There are no changes for purposes for which licensed material will be used from those currently authorized.

Item 7. Individuals responsible for the Radiation Safety Program and their training experience.

The members of the EMSL-LV Radiation Safety Committee (RSC) include the representative from management, Radiation Safety Officer (RSO), the Safety, Health and Environmental Manager (SHEM), Facilities Manager and Authorized Users of radioactive materials. The Chairperson is Donald M. Daigler. Co-Authorized Users, annotated in parentheses, assume the responsibilities of the Authorized User in his absence. Each individual's training experience is attached (Enclosures 1 - 22).

<u>RSC Membership</u>.

J. Gareth Pearson, #1, Acting Deputy Director of the Laboratory.

Loyd D. Carroll, #2, Radiation Safety Officer.

Douglas C. Sharp, #3, Safety, Health and Environmental Manager, Office of Program Management and Support.

Frederick L. Childers, #4, Facilities Manager, Office of Program Management and Support.

Authorized Users, Nuclear Radiation Assessment Division (NRD).

Donald M. Daigler, #5 (Christopher A. Fontana, #6).

George A. Dilbeck, #7 (Paul B. Hahn*, #8 and John D. Akridge, #9).

Scott H. Faller, #10 (Paul B. Hahn*, #8).

NRC FORM 313 (6-93)
10 CFR 30, 32, 33, 34, 35, 36, 39 and 40

U. S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIAL LICENSE

APPROVED BY OMB: NO. 3150-0120
EXPIRES 6-30-96

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 9 HOURS. SUBMITTAL OF THE APPLICATION IS NECESSARY TO DETERMINE THAT THE APPLICANT IS QUALIFIED AND THAT ADEQUATE PROCEDURES EXIST TO PROTECT THE PUBLIC HEALTH AND SAFETY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0120), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

LICENSING ASSISTANT SECTION
NUCLEAR MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION II
101 MARIETTA STREET, NW, SUITE 2900
ATLANTA, GA 30323-0199

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137-5927

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TX 76011-8064

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

RADIOACTIVE MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION V
1450 MARIA LANE
WALNUT CREEK, CA 94596-5368

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S.NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [ ] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER _____
- [X] C. RENEWAL OF LICENSE NUMBER 27-05861-02

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip code)*

US Environmental Protection Agency
Environmental Monitoring Systems Lab
P. O. Box 93478
Las Vegas, Nevada 89193-3478

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

US Environmental Protection Agency
Office of Research and Development
Environmental Monitoring Systems Laboratory-LV
944 East Harmon Avenue
Las Vegas, Nevada

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Radiation Safety Officer
Loyd D. Carroll

TELEPHONE NUMBER

(702) 798-2313

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5.	RADIOACTIVE MATERIAL a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.	6.	PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7.	INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.	8.	TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9.	FACILITIES AND EQUIPMENT.	10.	RADIATION SAFETY PROGRAM.
11.	WASTE MANAGEMENT.	12.	LICENSEE FEES *(See 10 CFR 170 and Section 170.31)* FEE CATEGORY / AMOUNT ENCLOSED $ N/A

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39 AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER -- TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Wayne N. Marchant, Director	Wayne N Marchant	2/11/94

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

PRINTED ON RECYCLED PAPER

Item 7 (continued).

Robert W. Holloway, #11 (Dennis E. Farmer, #12).

Anita A. Mullen, #13 (Herbert K. Mauru, #14).

Other Authorized Users.

Gary L. Robertson, #15 (John M. Nocerino, #16), Quality Assurance and Methods Development Division (QAD).

Jeffre C. Johnson, #17 (Jeanette M. Van Emon, #18), Exposure Assessment Division (EAD).

Gregg D. Dempsey, #19 (Colleen F. Petullo, #20), Office of Radiation and Indoor Air (ORIA).

Richard D. Hopper, #21 (Gregory J. Budd, #22), Office of Radiation and Indoor Air (ORIA).

Item 8. Training for individuals working in or frequenting restricted areas.

Training requirements are specified in the Radiation Safety Manual, paragraph D.

Item 9. Facilities and equipment.

The information for our facilities and equipment previously submitted in our NRC material license renewal application in January, 1989, is the same, with the exception for the following two changes.

a. Please add the EPA Government Parking Compound (drawing, Enclosure #23) which was inadvertently not submitted with our previous NRC license renewal application in January, 1989. This area is located adjacent to and southwest from the Radiation Operations Center (ROC) building, 4220 South Maryland Parkway. This is a secured, fenced area used by NRD and ORIA personnel for the parking of EPA vehicles which contain low-level or exempt quantities of radioactive materials which are used as standards for calibrating equipment in the field or laboratory grade instruments in the vehicles. ORIA vehicles are used for responding to nation-wide radiological emergencies. During duty hours, the northern entrance gate remains open and unattended vehicles in the compound are secured and locked.

b. Please delete the Special Use Isotope Facility (Hot Lab) in room 46 of the Quality Assurance Laboratory (QAL) building. All radioactive materials were removed from this room

Item 9 (continued).

and a close-out radiation protection survey was performed by the RSO in the latter part of 1992.

Each area for the use and storage of radioactive materials and other sources of ionizing radiation is approved by the Radiation Safety Committee. Current authorized areas at this time include the basement in the Executive Center Building; the Radon chambers in the Exposure Assessment Annex (EAX); the Calibration Facility in room 18, Monitoring Systems Laboratory (MSL); rooms 3, 4, and 45 in the Quality Assurance Laboratory (QAL); rooms 12, 14, 15, 23, 26, 35, 36, 37, 41, 42, 43, 44, 61, 62 and 63 in the Chemistry Laboratory (CHL); and room 519 and the vehicle parking compound area at the Radiation Operations Center.

Item 10. Radiation Safety Program.

The operating procedures for the EMSL-LV Radiation Safety Program are specified in the EMSL-LV Radiation Safety Manual, dated February, 1994 (Enclosure #25), which supersedes the previous manual dated December, 1988.

a. Please reference those letters and facsimiles for license amendment requests in Condition #26 of Amendment #18 for information that is either current or has been superseded by Amendment #18 or new procedures in the Radiation Safety Manual.

(1) Letter dated March 13, 1989. This request for the specified radiation source has been superseded by Amendment #18.

(2) Letter dated April 19, 1990. The request in paragraph 1 for the 5 mCi Co-60 sealed source, Model 375, is included in Amendment #18 and those procedures for the Calibration of Field Deployed Pressurized Ion Chambers (PIC) by the use of this source are current. Please note that these procedures are not included in the Radiation Safety Manual. The NRO-55 procedure, Subject: Direct Reading Dosimeters, dated February 1990, which is referenced (and provided) in the PIC calibration procedures, has been superseded by another approved procedure. All other requests in paragraphs 2 - 9 have been superseded by Amendment #18.

(3) Letters dated July 26, October 15, November 9, 1990, and May 8, 1991. Excluding the "Statement of Intent - Financial Assurance for Decommissioning of Facilities used under Material License Number 27-05861-02," dated May 8, 1991, which is current, all other information in these letters requesting changes to radionuclides has been superseded by Amendment #18.

Item 10 (continued).

(4) Letters dated December 19, 1991, and January 7, 1992. The information relating to EMSL-LV's DOELAP accreditation in paragraph 5, both letters, is current. The training requirements in paragraph 4, both letters, is being replaced by paragraph D in the Radiation Safety Manual. Those requests in paragraphs 1 - 3 in the December letter have been superseded by Amendment #18.

(5) Letter dated April 7 and telefacsimile dated April 29, 1992. Those requests in paragraphs 1 and 2 and the telefacsimile have been superseded by Amendment #18. The information in paragraph 3 for EMSL-LV's DOELAP accreditation is a repeat of the same information in paragraph 5 of the letter dated December 19, 1991.

(6) Letter dated July 17, 1992. The information for the EMSL-LV Director in paragraph 1 is current. The request in paragraph 2 has been superseded by Amendment #18.

(7) Letters dated July 27, September 7, November 12, and facsimile dated December 13, 1993. The various requests pertaining to radionuclides and their uses (items 6-9) in the letters dated July 27 and November 12, and the switching of the RSO and RSC Chairperson positions in the letter dated September 7, have been superseded by Amendment #18. Those requested procedural changes in the letter dated July 27, paragraphs a - d, pages 1 - 3, for the procurement of radioactive materials (a), receipt and opening of radionuclide shipments (b), performance and frequency of surveys and annual calibration requirements (c), and posting of notices to workers (d) are being replaced with new procedures in the Radiation Safety Manual. Those procedures for the electrodeposited sources (NRA 1.12, Revision 2.0, pages 21 and 22, dated September 30, 1992) provided in the facsimile dated December 13, 1993, are current.

b. Radiation Safety Committee. The composition, responsibilities and meeting requirements for the committee are specified in the Radiation Safety Manual, paragraph B1.

c. Radiation Safety Officer (RSO). The RSO is a full-time paid employee and the position is a part-time assignment. The responsibilities of the RSO are specified in the Radiation Safety Manual, paragraph B2.

d. Administrative procedures for the control of procurement and the use of licensed material and completion of safety evaluations of proposed uses of licensed material. Please refer to appropriate paragraphs in the Radiation Safety Manual for these requirements.

Item 10 (continued).

e. Personnel Monitoring. Appropriate procedures and requirements are specified in the Radiation Safety Manual, paragraphs E8, F, G and I. EMSL-LV's DOELAP Certificate of Accreditation and the conditions for this accreditation are attached (Enclosure #24) and the reaccreditation is currently being pursued. Xenon-133 and Iodine-125 in dispersible forms are not normally used. The maximum amount of Iodine-131 in dispersible form handled by personnel at any one time is less than 120 microcuries, which normally occurs once each quarter.

f. Calibration of instruments used for licensed activities. These procedures are specified in the Radiation Safety Manual, paragraph P.

g. Emergency Procedures. Radiological emergency procedures are specified in the Radiation Safety Manual, paragraph R.

Item 11. Waste Management.

The disposal of radioactive waste will be in accordance with the Radiation Safety Manual, paragraph N, or as authorized by 10 CFR 20, Subpart K. Shipments of radioactive waste are normally contracted to an authorized and licensed broker for the packaging, transportation and ultimate disposal of the waste.

Item 12. Licensee Fees (not required).

J. Gareth Pearson

Employment: U.S. Environmental Protection Agency (EPA)
Environmental Monitoring Systems Laboratory (EMSL)
Las Vegas, Nevada

07/92 - present: Acting Deputy Laboratory Director
Direct and manage the day-to-day activities for the operation of the laboratory: plan and execute the budget, plan and review technical programs, procurements and transfers of funds and provide oversight to Technical Support Center.

11/91 - 07/92: Acting Laboratory Director
Organized and directed the planning and implementation of research development and demonstration programs in environmental measurement and monitoring systems.

11/86 - 11/91: Director, Exposure Assessment Research Division
Conducted basic and applied research in total human exposure monitoring and modeling, terrestrial and ecological monitoring, and provide technical assistance to the EPA's Regional Offices.

04/83 - 11/86: Chief, Toxics and Hazardous Waste Operations Br.
Directed and managed administrative and technical support to conduct research in biological/bioanalytical methods development and validation for EPA's Offices of Solid Waste and Toxic Substances. Developed and designed QA procedures and programs for these two offices, in addition to the EPA Office of Emergency and Remedial Response.

10/80 - 04/83: Research Biologist, Quality Assurance Division
As Matrix Manager, coordinated and developed various research projects and programs for EPA's Hazardous Waste Monitoring Research Program for 3 EPA laboratories.

Employment as Research Biologist: (08/73 - 10/80) US Army Medical Bioengineering and Development Lab and US Army Medical Research and Development Lab, Ft. Detrick, Frederick, MD and US Army Edgewood Arsenal, APG, MD.

US Army, 1969-1973, graduate of Chemical Officers Basic Course

Education:

B.A. (1967) and M.A (1969) in Zoology
University of California, Santa Barbara, California
Environmental Biology course work, Johns Hopkins University

Professional Affiliations:

American Fisheries Society (Certified Fisheries Biologist)
American Institute of Fisheries Research Biologists
American Society of Testing and Materials
Society of Environmental Toxicology and Chemistry
International Society of Exposure Analysis

Encl #1

Curriculum Vitae

Loyd D. Carroll

Employment

Health Physicist, GS-1306
US Environmental Protection Agency
EMSL-LV, Nuclear Radiation Assessment Division
Las Vegas, Nevada 89193-3478
October 1991 - present

Public Health Physicist II
State of Florida, Dept of Health and Rehabilitation Svc
Radiation Control, 400 W. Robinson, Suite S-529
Orlando, Florida 32801
August - October 1991

US Army 1975 - 1991

Chief, Health Physics Office (RSO)
Tripler Army Medical Center
Honolulu, Hawaii 96859
December 1986 - August 1991

Chief, Radioisotopes Branch (RSO) and QA Officer
Letterman Army Insititute of Research
Presidio of San Francisco, California 94129
July 1983 - July 1986

Radiation Safety Officer (RSO)
General Leonard Wood Army Community Hospital
Fort Leonard Wood, Missouri 65473
September 1980 - July 1983

Nuclear Medicine Technologist (Alternate RSO)
General Leonard Wood Army Community Hospital
Fort Leonard Wood, Missouri 65473
September 1978 - July 1980

Nuclear Medicine Technologist
William Beaumont Army Medical Center
El Paso, Texas 79920
December 1977 - September 1978

Physical Scientist Assistant
US Army Nuclear Agency
Weapon Effects Division
El Paso, Texas 79919
March 1975 - August 1977

Encl #2

Curriculum Vitae (cont)

Loyd D. Carroll

Education/Schools

West Texas State University, BS in Biology, 1975
George Washington University, AS in Nuclear Medicine, 1981

Fundamentals of Radiological Health Physics, 13-18 Jan '92
Environmental Radiation Monitor Refresher Class, 6-8 Nov '91
Medical Effects of Nuclear Weapons, 13-14 Aug '90
Good Laboratory Practices Course, 26-27 Jan '84
Nuclear Medical Science Officer Workshop, 17-21 Oct '83
Nuclear Medical Science Officer Workshop, 19-23 Oct '81
Integrating Hospital Quality Assurance, 29 Sep '81
Medical X-ray Survey Techniques Course, 11-22 May '81
Radiation Protection Officer Workshop, 14-18 Apr '80
Microwave Survey Techniques Workshop, 26-27 Mar '79
Leadership Management Development Course, 5-9 Nov '78
Clinical Nuclear Medicine Technician Course, Jan-Sep '78
Clinical Nuclear Medicine Technical School, Aug-Dec '77
Disaster Control Specialist Course, 24-27 Apr '67

Affiliations

Health Physics Society, Plenary Member, 1981
Nuclear Medicine Technology Certification Board, 1978

FORM NRC-313M-SUPPLEMENT A
(8-78)

U.S. NUCLEAR REGULATORY COMMISSION

TRAINING AND EXPERIENCE
AUTHORIZED USER OR RADIATION SAFETY OFFICER

1. NAME OF AUTHORIZED USER OR RADIATION SAFETY OFFICER	2. STATE OR TERRITORY IN WHICH LICENSED TO PRACTICE MEDICINE
Loyd D. Carroll	

3. CERTIFICATION

SPECIALTY BOARD A	CATEGORY B	MONTH AND YEAR CERTIFIED C

4. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

FIELD OF TRAIN A	LOCATION AND DATE(S) OF TRAINING B	TYPE AND LENGTH OF TRAINING	
		LECTURE/ LABORATORY COURSES *(Hours)* C	SUPERVISED LABORATORY EXPERIENCE *(Hours)* D
a. RADIATION PHYSICS AND INSTRUMENTATION	1. Nuclear Medicine Tech School US Navy, NNMC, Bethesda, MD August-December 1977 2. William Beaumont Army Med Ctr Nuclear Medicine Technician El Paso, TX 01-09, 1978 3. Ft. Leonard Wood Army Hospit. NCOIC, Nuclear Medicine Serv. Ft. Leonard Wood, MO 10/78-07/80 4. RSO at US Army Medical Centers and Research Center Aug 1980 - July 1991	1. 22 weeks 2. 9 months	3&4. 12 yrs
b. RADIATION PROTECTION	" "	1. 22 weeks 2. 9 months	3&4. 12 yrs
c. MATHEMATICS PERTAINING TO THE USE AND MEASUREMENT OF RADIOACTIVITY	" "	1. 22 weeks 2. 9 months	3&4. 12 yrs
d. RADIATION BIOLOGY	" "	1. 22 weeks 2. 9 months	3&4. 3 yrs
e. RADIOPHARMACEUTICAL CHEMISTRY	" "	1. 22 weeks 2. 9 months	3&4. 3 yrs

5. EXPERIENCE WITH RADIATION. *(Actual use of Radioisotopes or Equivalent Experience)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Atomic # 3-83	50 mCi each	US Army Medical and Research Centers	Jan 1978-July 1991	Medical/Therapy
Tc99m/Mo99	6 Curies	"		In vitro studies
I-125	500 mCi		"	Research/Development
I-131	2 Curies	"		"
Cs-137	5,000 Curies/sealed		"	"
Co-60	9,000 Curies/sealed			

CURRICULUM VITAE

Douglas C. Sharp
EPA EMSL-LV Office of Program Management
Safety, Health and Environmental Manager
6/91 to present

The Bionetics Corporation (in-house contractors to EPA EMSL-LV Advanced Monitoring Systems Division EPIC field station, Warrenton, VA)
Environmental Compliance Coordinator/Health and Safety Officer
9/81 - 6/91

EPA AMD/EPIC
Physical Science Technician (Stay-In-School)
12/77 - 9/81

9/81 Bachelor of Arts, Chemistry, George Mason University, Fairfax, VA

12/80, Associate of Science, Science Curriculum, Northern Virginia Community College, Annandale, VA

Encl #3

SUBJECT: RESUME

NAME: FRED L. CHILDERS
DOB: JULY 28, 1947
SSN: 332-40-8785

MILITARY EXPERIENCE:

8/66 TO 8/74-U.S. NAVY-AVIATION ELECTRICIAN
8/74 TO 8/78-U.S. NAVY RESERVE-AVIATION ELECTRICIAN
8/84 TO PRES-U.S. NAVY RESERVE-INTELLIGENCE SPECIALIST

CIVILIAN WORK EXPERIENCE:

4/65 TO 04/84-I WORKED FOR A CONSTRUCTION FIRM CALLED AMERICAN TECHNOLOGIES. I STARTED WITH THIS COMPANY IN HIGH SCHOOL AS A MATERIAL EXPEDITER AND ENDED UP AS A SUBSIDIARY COMPANY PRESIDENT WITH OVER 150 EMPLOYEES DOING OVER $7MIL WORTH OF CONSTRUCTION PER YEAR. THESE CONTRACTS INCLUDED MULTI-STORY CONDOMINIUMS, LARGE SCHOOL PROJECTS, A LARGE DISTRIBUTION CENTER AND A LARGE JUSTICE CENTER THAT INCLUDED A STATE OF THE ART COURT HOUSE AND JAIL. WE WERE AN ELECTRICAL, PLUMBING, HVAC AND FIRE PROTECTION CONTRACTING FIRM. I HAD FOUR GENERAL SUPERINTENDENTS THAT DIRECTED A WORK FORCE OF OVER 150 TRADES PEOPLE.

4/84 TO 10/87-I WORKED FOR A GOVERNMENT CONTRACTOR CALLED HARRIS CORPORATION. AS A FACILITY MANAGER AT CORPORATE HEADQUARTERS, I WAS RESPONSIBLE FOR PHYSICAL PLANT MAINTENANCE. OUR FACILITY CONSISTED OF TWENTY FIVE BUILDINGS AND OVER 2.5 MIL SQ. FT. OF OFFICE, RESEARCH, MANUFACTURING AND SPECIAL PURPOSE SPACE ON A SITE OVER FIFTY ACRES. I HAD FIVE GENERAL SUPERINTENDENTS THAT DIRECTED A WORK FORCE OF OVER 75 TRADES PEOPLE.

10/87 TO 4/90-I WORKED FOR THE DEFENCE INTELLIGENCE AGENCY AS THEIR FACILITY MANAGER AT THE DEFENCE INTELLIGENCE ANALYSIS CENTER (A 950,000 SQ FT OFFICE AND RESEARCH FACILITY) I PROVIDED PLANNING AND CONSULTATION SERVICES IN CONNECTION WITH SPACE UTILIZATION, ACQUISITION, DESIGN AND CONSTRUCTION OF DIA OPERATIONS, ADMINISTRATIVE, ACADEMIC AND SPECIAL PURPOSE FACILITIES. I WAS ALSO RESPONSIBLE FOR THE MAINTENANCE OF THE PHYSICAL INCLUDING OVERSEEING A LARGE JANITORIAL SERVICES CONTRACT.

Encl #4

4/90 TO 4/92--I JOINED EPA AT THEIR CORVALLIS, OREGON ENVIRONMENTAL RESEARCH LABORATORY, WHERE I WAS RESPONSIBLE FOR DESIGN, OPERATION, MAINTENANCE AND REPAIR OF A UNIQUE RESEARCH FACILITY OF OVER 130,000 SQFT OF OFFICE, ADMINISTRATIVE, LABORATORY AND RESEARCH SPACE. THE FACILITY CONSISTED OF TWO LABORATORY/OFFICE BUILDINGS, A UNIQUE WILDLIFE TOXICOLOGY COMPLEX, A STATE OF THE ART PLANT EXPOSURE COMPLEX, GREENHOUSES AND PLANT GROWTH CHAMBERS, OUTDOOR TEST PONDS. WITHIN THESE BUILDINGS WERE UNIQUE EXPERIMENTAL FACILITIES USED FOR A VARIETY OF INTERNATIONALLY LEADING RESEARCH PROGRAMS ON BIO-TECHNOLOGY, WILDLIFE TOXICOLOGY, PLANT PHYSIOLOGY, SOIL MICROBIOLOGY AND ENVIRONMENTAL CHEMISTRY.

4/92 TO PRES.-I TRANSFERRED WITH THE EPA TO THEIR ENVIRONMENTAL MONITORING SYSTEMS LABORATORY IN LAS VEGAS, NEVADA. I PROVIDE FACILITY MANAGEMENT FOR EMSL-LV AS WELL AS FOUR CO-LOCATED AGENCY ORGANIZATIONS WHICH INCLUDE APPROXIMATELY 150,000 SQFT OF OFFICE, ADMINISTRATIVE, LABORATORY AND RESEARCH SPACE. I PLAN, DIRECT AND COORDINATE FACILITY CONSTRUCTION PROJECTS TO REPAIR OR IMPROVE EXISTING BUILDING STRUCTURES AND MECHANICAL, ELECTRICAL AND FIRE PROTECTION SYSTEMS. THIS INCLUDES PRE-PLANNING AND INSTALLING BUILDING SERVICES FOR THE IMPLEMENTATION OF SCIENTIFIC INSTRUMENTATION, COMPUTER SYSTEMS, AND/OR RESEARCH APPARATUS. I SUPERVISE TWO SUPPLY MANAGEMENT SPECIALISTS AND TWO SEEP EMPLOYEES. I OVERSEE PROPERTY MANAGEMENT, MAIL SERVICE AND WAREHOUSE FUNCTIONS AS WELL AS ACT AS PROJECT OFFICER FOR THE OPERATIONS AND MAINTENANCE CONTRACT.

Donald M. Daigler

Work Experience

5/91-present **Health Physicist**
Environmental Protection Agency
Las Vegas, Nevada

Radiation Safety Committe Chair for the EPA Environmental Monitoring Systems Laboratory. Responsible for chairing quarterly radiation safety committee meetings. Working with other laboratory management and the Radiation Safety Officer ensure compliance with Nuclear Regulatory requirements.

Team Leader - External Dosimetry Program responsible for oversight of a comprehensive environmental and personnel monitoring program.

Calibration Officer assigned to the EPA Nuclear Radiation Assessment Division to manage the Divisions calibration programs. Programs include: environmental/personnel monitoring, laboratory analysis, and dose assessment.

Other duties include developing and conducting training on radiation instrumentation and radiation safety, developing and reviewing operating procedures, conducting technical audits, and participating in or directing elements of the EPA Emergency Preparedness Program. Currently possess active DOE "Q" clearance.

12/89-5/91 **Radiological Instrumentation Lead Technician IV**
Reynolds Electrical and Engineering Company Inc.
Las Vegas, Nevada

Assigned to the Environmental Protection Agency, Nuclear Radiation Assessment Division, to develop and manage a radiation instrumentation maintenance and calibration program for the Offsite Monitoring Branch. Involved in all technical and operational aspects associated with the Branch's radiation monitoring operations. Develop calibration, operational, and maintenance procedures to ensure the program meets Nuclear Regulatory Commission licensing requirements.

Encl #5

12/84-12/89 **Radiological Instrumentation Le**
Reynolds Electrical and Engi
Mercury, Nevada

Assigned to the Los Alamos
Health Physics Group, as
included managing the t
assigned technician
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environmental/
(both fixed
Departmer
Test

9/80

8/9

1/91

6/87

Donald M. Daigler

Work Experience

5/91-present **Health Physicist**
Environmental Protection Agency
Las Vegas, Nevada

Radiation Safety Committe Chair for the EPA Environmental Monitoring Systems Laboratory. Responsible for chairing quarterly radiation safety committee meetings. Working with other laboratory management and the Radiation Safety Officer ensure compliance with Nuclear Regulatory requirements.

Team Leader - External Dosimetry Program responsible for oversight of a comprehensive environmental and personnel monitoring program.

Calibration Officer assigned to the EPA Nuclear Radiation Assessment Division to manage the Divisions calibration programs. Programs include: environmental/personnel monitoring, laboratory analysis, and dose assessment.

Other duties include developing and conducting training on radiation instrumentation and radiation safety, developing and reviewing operating procedures, conducting technical audits, and participating in or directing elements of the EPA Emergency Preparedness Program. Currently possess active DOE "Q" clearance.

12/89-5/91 **Radiological Instrumentation Lead Technician IV**
Reynolds Electrical and Engineering Company Inc.
Las Vegas, Nevada

Assigned to the Environmental Protection Agency, Nuclear Radiation Assessment Division, to develop and manage a radiation instrumentation maintenance and calibration program for the Offsite Monitoring Branch. Involved in all technical and operational aspects associated with the Branch's radiation monitoring operations. Develop calibration, operational, and maintenance procedures to ensure the program meets Nuclear Regulatory Commission licensing requirements.

Encl #5

12/84-12/89 **Radiological Instrumentation Lead Technician III**
Reynolds Electrical and Engineering Company Inc.
Mercury, Nevada

Assigned to the Los Alamos National Laboratory (LANL), Health Physics Group, as Lead Person. Responsibilities included managing the time and job assignments of other LANL assigned technicians and the evaluation of their work. Operate, calibrate, and maintain instrumentation used for environmental/personnel monitoring and laboratory analysis (both fixed and mobile laboratories) for support of the Department of Energy's Weapons Testing Program at the Nevada Test Site.

9/80-9/84 **Aircraft Armament Systems Specialist**
United States Air Force
Kadena A.F.B., Okinawa, Japan
Nellis A.F.B., Las Vegas, Nevada

Honorably Discharged with rank of Sergeant. Duties included: performing electronic tests on aircraft weapons systems and repair electronic failures; loading and unloading of aircraft munitions and associated launching systems.

Education and Training

2/92-present Thomas Edison State College, Trenton, New Jersey:
Major - Radiation Protection (71 credits)

6/90-5/91 University of Nevada Las Vegas, Las Vegas, Nevada:
Major - Radiological Health (38 credits)

9/84-6/90 Clark County Community College, Las Vegas, Nevada:
Major - Electronic Engineering Technology
(37 credits)

3/92 Radiation Safety Associates, Inc., Hartford Ct:
"Radiation Safety Officer Training" (40 hours)

8/91 Canberra Industries, Inc., Meriden, Connecticut:
"NRRPT Review" (80 hours)

1/91 Technical Management Services, Orlando, Florida:
"Radiation Detection and Measurement"
(40 hours - Instructor:Glenn F. Knoll)

6/87 Movonics Company/EG&G, Las Vegas, Nevada:
"Troubleshooting the IBM PC" (40 hours)

5/85-8/92	Reynolds Electrical and Engineering Co. Inc. Sponsored:
3/93	"Basic Instructor Training Course" (40 hours - Instructor: REECo)
8/92	"Counting Statistics" (24 hours - Instructor: Herman Cember)
10/90	"Basic Health Physics" (40 hours - Instructor: REECo)
1/89	"Fundamentals of Health Physics" (48 hours - Instructor: Dr. Kenneth Scrabble)
2/88	"PC-DOS I&II for IBM Computers" (8 Hours - Instructor: REECo)
4/87	"LOTUS 1-2-3: Introduction and Intermediate" (48 hours - Instructor: REECo)
1/86	"Transportation Of Radioactive Materials" (24 hours - Instructor: DOE)
12/85	"Metrology: Temperature, Humidity and Pressure Instruments" (16 hours - Instructor: REECo)
5/85	"Advanced Computer Concepts I and II" (80 hours - Instructor: REECo)

10/80-2/81	Air Force Technical School, Lowery Air Force Base, Colorado, Major - Aircraft Armament Systems.

Certifications

12/91	National Registry of Radiation Protection Technologists - (NRRPT)
12/89	The National Association of Radio and Telecommunications Engineers, Inc. - Class III Certified Technician

Christopher A. Fontana

P.O. Box 72542
Las Vegas, NV 89170
(702) 897-1802

OBJECTIVE: To broaden experience in my field of expertise, while participating in a challenging program.

DESIRED POSITION: Health Physicist, Physicist.

EDUCATION:

California State College Stanisiaus, Turlock, CA
B.S. in Physics, 1983

Physics courses ranged from Classical to Quantum Mechanics, Mathematical Physics, Electromagnetism, Modern Physics, Electronics Instrumentation, and Gravitational Wave Analysis. Advanced Physics Laboratory work included Electron Spin Resonance, and Nuclear Magnetic Resonance.

Polk Community College, Winter Haven, FL
A.A. in Physics, 1976

TRAINING:

Basic Radiological Health, certified August 31, 1984
Radiation Protection Technology, certificate September 14, 1984
Certification as Radiation Monitor (1986 - present)
Panasonic 7th International Symposium (1988)
Panasonic TLD System Operation, Certification (1989)
Theory of TLDs Relating to Panasonic, Week #1, Certification (1986)
Operation of Panasonic TLD Readers, Week #2, Certification (1987)
Operation of Panasonic TLD Program, Week #3, Certification (1991)
Statistical Applications in a TLD Program, Week #4, Certification (1991)
Technical Writing (1986)
dBase III plus (1987)
Lotus 123 (1987)
Federal Radiological Monitoring and Assessment Center (FRMAC), Fort Calhoun, Omaha Exercise (1993)
Hanford/FRMAC preparation course (1993)
FIDLER Training (1993)
FRMAC Monitoring and Analysis Working Group Attendee, August 20, 1993
FRMAC, Freemont, Hanford Exercise (1993)
FRMAC Training Working Group member (1993)
FRMAC Operations Course Assessor (1993)
FRMAC Evaluation and Assessment Working Group Meeting Attendee (10/93)

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Encl #6

TRAINING CONT'D:

Environmental Radiation Monitoring - Monitor Refresher Course (1992)
Radiation Safety Training (1992)
Emergency Response/FRMAC/Pu-Valley Exercise (1992)
Radiological Worker I Course Certification (1993)
Radiological Worker II Course Instructor (1993)
Basic Instructor Training Course (1993)
Total Quality Management (TQM) Awareness (1993)
Transportation Emergency Training and Radiological Assistance (TETRA), November 24-28, 1993.
International Science Associates (ISA) Thermoluminescent Dosimetry Software Training, December 8-10, 1993.

PUBLICATIONS:

"On Newtonian black Holes," abstract contributed paper to the AAPT/APS Winter Meeting, 1982

Project Coordinator and co-author of "Offsite Environmental Monitoring Report, Radiation Around United States Nuclear Test Areas, calendar years 1987-1990 inclusive"

"Onsite and Offsite Environmental Surveillance Around Tatum Salt Dome, Lamar County, Mississippi, April, 1990."

EXPERIENCE:

4/84-Present Health Physicist

US Environmental Protection Agency
Environmental Monitoring Systems Laboratory
Nuclear Radiation Assessment Division
Dose Assessment Branch
Las Vegas, NV

Thermoluminescent Dosimetry methods, and application. Maintains a "state of the art" working knowledge of the Panasonic thermoluminescent dosimeters (TLD) system. Acts as health physicist who has the responsibility to evaluate the operation and analyses of the TLD system, as such, investigates and devises experiments to find the cause of anomalous readings. In case of emergencies, operates the TLD system and handles the TLD system database.

As Training Officer for the Nuclear Radiation Assessment Division (NRD), maintains records, evaluates training requirements and establishes appropriate training, as needed.

Participates as part of a team to perform routine offsite monitoring in support of the U.S. Department of Energy (DOE) activities at the NTS. Supports and operates the CP-1 computer graphics system in regard to the NTS activities as required. Maintains proficiency and operational knowledge of the system at all times.

Additional information and references available on request.

Curriculum Vitae

George Albert Dilbeck

Professional Experiences

November 1991 - Present	Technical Team Leader, RADQA Group, Nuclear Radiation Assessment Division (NRD), Environmental Monitoring Systems Laboratory (EMSL), U.S. Environmental Protection Agency, Las Vegas, Nevada. Supervises multi-disciplinary staff of scientific and technical support personnel. These functions include the administration of the Intercomparison Cross Check Program for state, federal, private, and foreign laboratories requiring an external quality control program, and the Radioactive Standards Distribution Program. Also provides technical support concerning regulatory issues to Headquarters and Regional Offices. Provides technical laboratory audits and written responses to the corresponding Regional Offices for primacy state drinking water compliance monitoring facilities for radioactive contaminants, and technical presentations to professional organizations such as AWWA, NIST, etc., concerning Safe Drinking Water Act (SDWA) compliance rules and regulations, analytical methodology, instrumentation, and quality assurance issues.
1987 - 1991	Radiochemistry Laboratory Supervisor, Public Health Laboratories, Arkansas State Department of Health, Little Rock, Arkansas. Provided all laboratory compliance monitoring analyses for the SDWA radioactive contaminants for the State of Arkansas, analyzed all multimedia surveillance environmental samples collected around Arkansas Nuclear One and Two (Arkansas Power & Light Company) located in Russellville, Arkansas, and all wipe and smear tests collected by the Radiation Control Department at the Arkansas State Department of Health for all nuclear licensed facilities in the state (Arkansas is an agreement state) concerning both initial licensure and license renewal on a yearly basis.
1981 - 1986	Private business.
1976 - 1980	Senior Development Chemist, Ciba-Geigy Chemical Corporation, McIntosh, Alabama. Worked on all aspects of chemical development processes for implementing chemical activities from the laboratory and pilot plant operations into the final production facilities.

Education:

B.S. Chemistry, University of Central Arkansas, Conway, Arkansas, 1970.

Ph.D. Chemistry, Oklahoma State University, Stillwater, Oklahoma, 1974.

Post Doctorate Research, Vanderbilt University with Dr. Lamar Field, Nashville, Tennessee, 1975.

Publications:

Available upon request.

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Paul B. Hahn

Education

Bachelor of Science - Chemistry, 1962
University of Michigan
Master of Science - Analytical Chemistry, 1967
Iowa State University
Ph.D. - Analytical Chemistry, 1973
Iowa State University

Experience

Radiochemist and Radiological Health Instructor, 1962-65 and 1967-70, NE Radiological Health Laboratory, Winchester, MA
(USPHS Commissioned Corps)
Laboratory Manager, Radiation Management Corp. Philadelphia 1973-74
Supervisory Research Chemist, U.S. EPA, EMSL-LV, 1974-80
Health Physicist, U.S. EPA, ORP-LV, 1980-83
Chief, Evaluation Branch, ORP-LVF, 1983-1988
Chemist, Radiological Standards Distribution Program Radiochemistry Methods Development, EMSL-LV, 1988-1992.

Special Skills and Abilities

Analytical Chemistry, Radiochemistry, Electrochemistry, Radioactivity Instrumentation, Laboratory Management, Health Physics, Quality Assurance, Contract Management, Collaborative Testing, Computer Data Processing

List of Publications

"Improvement in a Method for the Determination of Sr-90 in Milk" Anachem Conference, Detroit, MI, 1963.

"Interlaboratory Study of Sr-90 Measurements in Milk - August 1963" Health Physics 11(9) 966-70 (1965).

"Activation Analysis for Trace Quantities of Iodine in Biological Materials" M.S. Thesis, Iowa State University and U.S. AEC Report IS-T-190 (1967).

"Ion Exchange Beads as Calibrated Microscopic Radioactivity Sources" Analytical Chemistry 41(13) 1608-12 (1970) [also presented at the Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, TN, 1969 and the Eastern Analytical Symposium (Invited paper) New York, NY 1969].

"Public Health Aspects of I-129 from the Nuclear Power Industry" Radiological Health Reports 12(4) 189-94 (1971).

"Sodium Tungsten Bronze as a Potentiometric Indicating Electrode for Dissolved Oxygen in Aqueous Solution" Analytical Chemistry 45(7) 1016 (1973) [also presented at Anchem Conference, Detroit, MI, 1972].

'Chelometric Titrations of Metal Cations Using the Tungsten Bronze Electrode" Analytical Chemistry 45(7) 1267 (1973).

Encl #8

"Tungsten Bronzes as Indicating Potentiometric Electrodes" Ph.D. Thesis, Iowa State University and U.S. AEC Report IS-T-597 (1973).

"Mixed-Potential Mechanism for the Potentiometric Response of the Sodium Tungsten Bronze Electrode to Dissolved Oxygen and in Chelometric Titrations" Analytical Chemistry, 46 553 (1974).

"Method for Measuring Dissolved Oxygen in Aqueous Solution Using Tungsten Bronzes as a Potentiometric Indicating Electrode" U.S. Patent a3,856,634 (1974).

"Method of Chelometric Titration of Metal Cations Using Tungsten Bronze Electrode" U.S. Patent a3,878,059 (1974).

"Counting Alpha Particles from the $^{6}Li + n$ Reaction by Track Etch Methods" Nuclear Instruments and Methods, 123, 111-116 (1975).

"Development of a Reference Method for the Measurement of Plutonium in Soil" Proc. Int. Conf. Environmental Sensing and Assessment, Las Vegas, NV (1975).

"Fusion Method for the Measurement of Plutonium in soil: Single Laboratory Evaluation and Interlaboratory Colloborative Test" U.S. EPA Report, EPA/600/7-77-078 (1977).

"A Present Challenge - The Service Analysis" Federation of Analytical Chemistry and Spectroscopy Societies Conference, Detroit, MI (1977).

"Metabolism of Americium-241 in Dairy Animals" U.S. EPA Report, EMSL-0539-22 (1978).

"Simultaneous Determination of Americium and Curium in Soil," Analytical Chemistry 51 (2),295 (1979).

"Comparison of the Solubility of Plutonium-238 and Plutonium-239 Dioxide in In Vitro Bovine Ruminal-Gastronintestinal Fluids" U.S. EPA Report EMSL-LV-0539-28 (1979).

"Radiochemical Analytical Procedures for Analysis of Environmental Samples" U.S. EPA Report, EMSL-LV-0539-17 (1979).

"Comparison of Soil Sampling Techniques for Plutonium at Rocky Flats" Twenty-seventh Health Physics Society Annual Meeting, Las Vegas, NV (1982).

Patents

"Method for Measuring Dissolved Oxygen in Aqueous Solution Using Tungsten Bronzes as Potentiometric Indicating Electrode" U.S. Patent #3856634

"Method of Chelometric Titration of Metal Cations Using Tungten Bronze Electrode" U.S. Patent # 3878059

Paul B. Hahn

Formal Courses in Radiological Health and Radiochemistry

Physics, Radioisotopes Univ. of Michigan 1961
Physics, Modern Univ, of Michigan 1961
Environ. Health, Radiological Health Univ. of Mich. 1961
Radiochemistry I Iowa State Univ. 1966
Radiochemistry II Iowa State Univ. 1966
Civil Engg., Nuclear Waste Treatment Iowa State Univ. 1966
Nuclear Engg, Nuclear Fuels and Wastes Iowa State Univ. 1971
Nuclear Engg, Reprocessing Nuclear Fuels Iowa State Univ 1971
Transport of Radioactive and Hazardous Materials (3 days Las Vegas, 1989)

Experience with Radioactive Materials

1962-1967	Radiochemist U.S. Public Health Service Winchester, MA
1967-1970	Worked with uCi quantities of fission and activation products in the development of radiochemical methods. Instructor in PHS courses in Radiological Health, Gamma spectroscopy, Radiochemistry, and Radiological Surveillance.
1965-1967	Student, Iowa State University
1970-1973	Performed activation analysis using 5 mega watt reactor and radiochemical separations of short-lived activation products in the uCi-mCi activity range. Instructor in Radiochemistry Laboratory Course
1973-1974	Laboratory Manager Radiation Management Corp. Supervised the analysis of environmental samples for radioactive materials.
1974-Present	Radiochemist U.S. Environmental Protection Agency Las Vegas, NV. Work with uCi quantities of natural and artificially produced radionuclides for radiochemical methods development and for the preparation and calibration of radioactivity standards for distribution to participants in the EPA Radioactivity Performance Evaluation Studies Program. Prepared 10-100 mCi transuranium nuclide preparations using glove box techniques for biological uptake studies. Member of Department of Energy Radiological Assistance Team and participate in FRMAC laboratory and hot-line activities during field exercises and by preparing radioactive quality assurance samples for the evaluation of mobil laboratory performence.

RESUME'

John D. Akridge

Professional Positions

Present Position 1986 - present	**Chemist** US Environmental Protection Agency Environmental Monitoring Systems Laboratory Las Vegas, Nevada
1982 - 1986	**Group Leader, Radiochemistry** Additional duties: Radiation Safety Officer Environmental Science & Engineering, Inc. Gainesville, Florida
1975 - 1976	**Quality Assurance Manager** Hudson Foods, Inc. Noel, Missouri

Education

1982	University of Arkansas, Fayetteville Ph.D., Nuclear and Radiochemistry
1980	University of Arkansas, Fayetteville M.S., Radiochemistry
1975	Southwest Missouri State University, Springfield B.S., Biology and Environmental Chemical Technology
1968	Parkview High School, Springfield, Missouri High School Diploma

Encl #9

Curriculum Vitae

Scott H. Faller

Education

1979	B.A. Chemistry, Idaho State University, Pocatello, Idaho
1986	Ph.D. Nuclear Chemistry, University of Maryland, College Park, Maryland Thesis: "Structure of Odd-Z Lanthanum and Cesium Isotopes with N Larger than 82."

Professional Experience

1980	Industrial Chemist, J.R. Simplot Company, Pocatello, Idaho
1980-1986	Graduate Research Assisstant, University of Maryland, College Park, Maryland
1987-Present	Research Chemist and Group Leader (Gamma Analysis, Sample Control, and Whole Body Counting), Nuclear Radiation Assessment Division, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, Nevada

Professional Societies

American Nuclear Society (Southern Nevada Chapter)

Publications

1. "The Decay of 56-second Ce-148 to Levels of Odd-Odd Pr-148", N.K. Aras, C. Chung, C.A. Stone, S.H. Faller, W.B. Walters, R.L. Gill, M. Schmid, and R.E. Chrien. Can. J. of Chem. 61, 780(1983).

2. "The Beta Decay of I-139", J.D. Robertson, S.H. Faller, W.B. Walters, and C.A. Stone, R.L. Gill, and A. Piotrowski. Z. Phys. A321, 705(1985).

3. "Decay of 83-minute Ba-139 to Levels of La-139 and the Decay of 18-minute Ba-141 to Levels of La-141", S.H. Faller, C.A. Stone, J.D. Robertson, C. Chung, N.K. Aras, W.B. Walters, R.L. Gill, and A. Piotrowski. Phys. Rev. C34, 654(1986).

4. "The Decay of Cs-145 to Levels of Ba-145", J.D. Robertson, S.H. Faller, W.B. Walters, R.L. Gill, H. Mach, A. Piotrowski, E.F. Zganjar, H. Dejbakhsh, and R.F. Petry. Phys. Rev. C34, 1012(1986).

5. "Structure of the Odd-Odd and Odd-Mass Sb Nuclides", C.A. Stone, S.H. Faller, J.D. Robertson, and W.B. Walters. "Nuclei Far From Stability"; AIP Conference, Proc. 164, 429(1987).

6. "Decay of Ba-143 to Levels of the Odd-Proton N=86 Nuclide La-143", S.H. Faller, J.D. Robertson, E.M. Baum, C. Chung, C.A. Stone, and W.B. Walters. Phys. Rev. C38, 307(1988).

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7. "Decay of Xe-139,-141,-143 to Levels of Cs-139,-141,-143", S.H. Faller, P.F. Mantica,Jr., E.M. Baum, C. Chung, J.D. Robertson, C.A. Stone, and W.B. Walters. Phys. Rev. C38, 905(1988).

8. "Level Structure of Odd-Mass Pr Isotopes: Decay of 3.0 minute Ce-145 to Levels of Pr-145", E.M. Baum, J.D. Robertson, P.F. Mantica,Jr., S.H. Faller, C.A. Stone, W.B. Walters, R.A. Meyer, and D.F. Kusnezov. Phys. Rev. C39, 1514(1989).

9. "Thorium-230 Dating of Thermal Waters in the Vicinity of Yucca Mountain, Nevada", R.W. Holloway, J.T. Carilli, S.H. Faller, C.K. Liu, and P.K. Kuroda. J. Radioanal. and Nucl. Chem 131, 359(1989).

10. "Structure of Odd-Odd Sb-132", C.A. Stone, S.H. Faller, and W.B. Walters. Phys. Rev. C39, 1963(1989).

11. "Reflection Asymmetric Structures in the A=145 Mass Region: Decays of 1.8-s Cs-143 to Levels to Ba-143 and 4.1-s La-147 to levels of Ce-147", J.D. Robertson, P.F. Mantica,Jr., S.H. Faller, C.A. Stone, E.M. Baum, and W.B. Walters. Phys. Rev. C40, 2804(1989).

12. "Investigation of Cold Fusion in Heavy Water", S.H. Faller, R.W. Holloway, and S.C. Lee. J. Radioanal. Nucl. Chem. Letters 137, 9(1989).

13. "Ruthenium-103, Iodine-131, Tellurium-132, and Cesium-137 in Air after the Chernobyl Event", C.K. Liu, S.H. Faller, and P.K. Kuroda. Radiochimica Acta 50, 159(1990).

14. "Unusual Nuclide Concentrations in Air after the Chernobyl Event", S.H. Faller and P.K. Kuroda. Radiochimica Acta 50, 219(1990).

15. "Long-Lived Radioactivity in Surface Air over Washington D.C. after the Chernobyl Event", S.H. Faller, D.J. Krask, and P.K. Kuroda. Radiochimica Acta 54, 43(1991).

16. "Airborne Chernobyl Radioactivity in College Park, Maryland", M.E. Kitto, S.H. Faller, D.L. Anderson. and L.E. McCarthy. Radiochimica Acta 55, 43(1991).

17. "In-Situ Gamma-Ray Site Characterization of the Tatum Salt Dome Test Site in Lamar County, Mississippi", S.H. Faller. Health Physics 62, 571(1992).

18. "Environmental Monitoring Report: Radiation Monitoring On and Around the Tatum Salt Dome, Lamar County, Mississippi, April 1991", D.J. Thome, S.H. Faller, C.A. Fontana, and C.F. Costa. U.S. Environmental Protection Agency, Las Vegas, NV, Report EPA-600/4-91/031 (1991).

19. "Gamma-Ray Surface Characterization of the Gnome Test Site in Eddy County, New Mexico", S.H. Faller. Submitted to Health Physics.

RESUME

NAME: Robert Holloway

ADDRESS: 311 East Desert Rose
Henderson, NV 89015

PHONE: (702) 798-2325 (work)
(702) 564-7301 (home)

EDUCATION:

University of Arkansas	Ph.D. 1977, in chemistry with emphasis in radiochemistry and nuclear science
University of Oklahoma	A one year, non-degree program, completed in 1968 and equivalent to an undergraduate major in meteorology
Harding College	B.S., 1967, in Chemistry

EXPERIENCE:

1981-Present	Currently employed by the U.S. Environmental Protection Agency at Las Vegas, Nevada. Present duties include the supervision of six laboratory workers in the analysis of environmental samples for radioactive noble gases, tritium, strontium, plutonium, uranium and thorium. This work is in support of radiation monitoring in the vicinity of the Nevada Test Site. Recently taught a course in Health Physics at the University of Nevada at Las Vegas. Have often served as lead auditor in quality assurance audits of radiochemical laboratories. Currently a team leader in the Nuclear Emergency Search Team (NEST) program for the Department of Energy.
1979-1980	Research Chemist, Savannah River Laboratory. Worked on a study of plutonium and americium in the marine environment.
1976-1979	Assistant Professor of Chemistry, University of Arkansas at Pine Bluff. Taught general chemistry, quantitative analysis and physical science.
1972-1976	Graduate student at the University of Arkansas. Research involved radioactive fission products in the atmosphere. Mentor was Professor Paul Kuroda.

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1967-1972 Military Service. To rank of Captain in the Air Force. Studied meteorology for one year at the University of Oklahoma and was then assigned to a weather-related computer center in Washington.

SECURITY CLEARANCE:

I have a current Department of Energy "Q" Clearance

BIOGRAPHICAL LISTINGS:

Who's Who in the West, 1987 and 1989
Who's Who of Emerging Leader's of America, 1989

PROFESSIONAL SOCIETIES:

American Chemical Society
Health Physics Society

PUBLICATIONS:

1. Tritium in Surface Waters of the Western United States, R.W. Holloway, Submitted to Radiochimica Acta, 1993.

2. Uranium and Thorium Abundances Across the Cretaceous-Tertiary Boundary in Colorado, R.W. Holloway and D.E. Farmer, Chemical Geology, 89, (1990) 201-207.

3. Book Chapter, "Determination of Uranium in an Analytical Chemistry Laboratory", C.K. Liu, R.W. Holloway and J. Akridge, In Radon, Radium and Uranium in Groundwater, edited by Richard Cothern and Paul A. Rebers, Lewis Publishers, Chelsea, Mich., 1990.

4. Investigation of Cold Fusion in Heavy Water, S.H. Faller, R.W. Holloway and S.C. Lee, Journal of Radioanal. and Nuclear Chem. Letters, 137, 359-367, (1989).

5. Thorium-230 Dating of Thermal Waters in the Vicinity of the Nevada Test Site, R.W. Holloway, J.T. Carilli, S.H. Faller, C.K. Liu and P.K. Kuroda, Journal of Radioanal. and Nuclear Chem., 131, 359-367, (1989).

6. Xe-133 in California, Nevada and Utah from the Chernobyl Accident," R.W. Holloway and C.K. Liu, Environmental Science and Technology, 22, 583 (1988).

7. Concentrations of Krypton-85 Near the Nevada Test Site, R.F. Grossman and R.W. Holloway, Environmental Science and Technology, 19, 1128 (1985).

8. The Mean Residence Time of Plutonium in the Troposphere, R.W. Holloway and D.W. Hayes, Environmental Science and Technology, 16, 172 (1982).

9. Transuranics in a Stream Near a Nuclear Fuel Chemical Separations Plant, R.W. Holloway and D.W. Hayes, Du Pont Report DP-1592, (1981).

10. Seasonal Variations in the Removal Rate of Material Injected into the Lower Stratosphere, R.W. Holloway, Environmental Science and Technology, 13, 1488 (1979).

11. Temporal Variations of Pb-212 In Thunderstorms, M.B. Gavini, R.W. Holloway, R.D. Sherrill, K.G. Inn and P.K. Kuroda, J. of Geophys. Res., 81,1148 (1976).

12. Sodium, Potassium, Calcium and Magnesium Content of Northwest Arkansas Rainwater in 1973, G.H. Wagner and R.W. Holloway, J. of Applied Meteorology, 14, 578 (1975).

13. The Ratios of Fission Product Pairs with Similar Half-Lives in the Atmosphere, R.W. Holloway, N.G. Sumerlin, J.N. Beck and P.K. Kuroda, J. of Geophys. Res., 79, 4453, (1974).

ORAL PRESENTATIONS:

1. Tritium in the Environment. Presented at the 38th Annual Conference on Bioassay, Analytical and Environmental Radio-Chemistry, Santa Fe, New Mexico, November 1992.

2. Uranium, Tritium and Thorium as Environmental Tracers. An invited talk presented in Warsaw, Poland at a Conference sponsored by Poland's Central Laboratory for Radiological Protection, August, 1992.

3. Uranium and Thorium Abundance Measurements Across the K-T Boundary in Colorado. Presented at the 34th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Oak Ridge, Tennessee, October, 1989.

4. Radioactivity in Springs and Surface Waters of Southern Nevada. Presented at the 33rd Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, Las Vegas, Nevada, October, 1988.

5. The Analysis of Radon by Gas Chromatography. Presented at the 32nd Conference on Bioassay, Analytical and Environmental Radiochemistry, Berkeley, California, November, 1987.

Dennis Farmer
USEPA - EMSL
Nuclear Radiation Division

EDUCATION:

- *B.S. Biology, University of Nevada - Las Vegas, NV 89119*
- *Advanced courses in isotope hydrology, geochemistry.*

WORK EXPERIENCE:

- *Environmental Scientist, 2 years experience, - prepare radioactive standards from NIST materials; calibration of alpha spectroscopy equipment.*
- *Radiochemistry laboratory technician, 3 years experience.*
- *Field radiation monitor, 3 years experience.*

TRAINING:

- *Basic health physics course, 1 week, (1986) San Antonio, TX.*
- *Radiological emergency response course, 1 week, (1987), Nevada Test Site, Mercury, NV.*
- *Advanced health physics course, 1 week, (1988), Las Vegas, NV.*
- *Radiochemical counting statistics, 1 week, (1991), Las Vegas, NV.*

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Anita Anne Lewis Mullen

Professional Experiences

July 1993 - Present — Chief, Nuclear Radiation Monitoring and Assessment Branch. Nuclear Radiation Assessment Division (NRD), Environmental Monitoring Systems Laboratory (EMSL), U.S. Environmental Protection Agency, Las Vegas, Nevada. Supervise multi-disciplinary staff of scientific and technical support personnel. Direct field operations aspects of EMSL's radiological safety program at the Nevada Test Site and other Department of Energy testing sites. Direct internal and external dosimetry operations including Whole Body Counting and Thermoluminescent Dosimetry programs. Direct data validation and report generation including computer science support for the NRD.

1992 - 1993 — Acting Branch Chief, Nuclear Radiation Dose Assessment Branch. Nuclear Radiation Assessment Division, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, Nevada. Health Physics, Internal and External Dosimetry, data analysis, evaluation, interpretation and presentation, Nevada Test Site support and radiological emergency response.

1988 - 1992 — Health Physicist, U.S. Environmental Protection Agency. Operation of the Whole-Body Counting Facility. This facility utilizes state-of-the-art instrumentation to carry out a human surveillance program to measure, identify and evaluate in vivo, the presence of internally deposited radionuclides, and determine internal doses received by people from environmental contamination or through occupational exposure.

1969 - 1988 — Radiochemist, Radiobiologist, Supervisory Chemist, Health Physicist, U.S. Environmental Protection Agency. Involved in the analysis of environmental contaminants released from the Nevada Test Site. Project officer for the determination of the transfer of various radionuclides through the chain to chickens, rabbits, goats and dairy cows and subsequent ingestion by man. Conducted radiobiological studies on rats and hamsters to determine internal dose from inhaled "hot particles" and subsequent tumor production.

1960 - Present — Serves as offsite radiation monitor to measure radiation releases to the environment and to protect the public from unnecessary exposure. Maintain readiness to respond to nuclear emergencies regardless of where they occur.

Education:

B.S. Degree, Buena Vista College, Storm Lake, Iowa, 1955
Double Major - Chemistry/Biology

Iowa State University, Ames, Iowa
Graduate School Biochemistry, 1956

Societies:

American Chemical Society
Health Physics Society

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Numerous publications on Radionuclide Metabolism.

Curriculum Vitae

Herbert Maunu
Supervisory Environmental Protect Specialist
Monitoring and Assessment Branch
Nuclear Radiation Assessment Division
Office of Research and Development
Environmental Monitoring Systems Laboratory- Las Vegas

Education

University of Nevada-Las Vegas, General - 28 Credits - 1973
Clark County Community College, General - 32 Credits - 1974

Work Experience

August 19[illegible] to present:

As supervisory of the field monitors, I am responsible for maintenance, repair, calibration and exchange of all air Sampling equipment, Gamma Rate Recorders, Tritium and Noble Gas Samplers. Review and make correction on all data from the above networks. Check any abnormalities in radiation background. Evaluate prototype Noble Gas and portable Air Samplers for Off-Site Radiation Monitoring. Serves as offsite radiation monitor to measure radiation releases to the environment and to protect the public from unnecessary exposure. Maintain readiness to respond to nuclear emergencies regardless of where they occur. I was also the chief technician of the Dosimetry Network, I was responsible for the preparation, issuance, collection, processing and preliminary data analysis of thermoluminescent dosimeters (TLD's) used in the Nevada Test Site Off-Site Program and the EMSL-LV Radiation Safety Program. This included the calibration, evaluation, maintenance and quality control of all dosimeters used in the network. I routinely, give instruction and guidance to others.

Formal Courses:

U.S. Public Health Service 944 East Harmon Las Vegas, Nevada 89109	80 Hrs - 1969
Basic Radiation Health Course	40 Hrs - 1963
Basic Radiation Health Course	32 Hrs - 1969
Radiation Protection Technology	40 Hrs - 1980
Radiation Emergency Response Operations	164 Hrs - 1981
Radiation Protection Instrumentation Harvard School of Public Health	40 Hrs - 1988

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RESUME
for
GARY ROBERTSON

EDUCATION:

1966 B.S. Chemistry-University of Iowa, Iowa City, Iowa. Included 3 Sem. Hrs. of Radiochemistry.

1980-83 GC/MS training short courses
4000 seies operator
INCOS operator
INCOS quantitation
INCOS electronic maintenance
Capillary column GC/MS
1020/OWA operator
Analysis of priority pollutants by GC/MS

EXPERIENCE:

1989-present U.S.EPA EMSL-LV. Chemist in Quality Assurance Research Branch. Duties primarily involve quality assurance related to the U.S.EPA Contract Laboratory Program. Duties also include laboratory research using gas chromatograph utilizing an electron capture detector.

1985-1989 Lockheed Engineering and Sciences Company. Chemist providing support to U.S.EPA EMSL-LV.

1968-1985 University of Iowa Hygienic Laboratory Performed drinking water analyses and supervised GC/MS laboratory. 1981-83 was a member of the state radiological emergency monitoring team for the local nuclear power plant (Duane Arnold). Participated in three annual one day exercises.

1966-1968 U.S. Army. Assigned to infantry. Participated in CBR training and worked as assistant company CBR NCO.

1963-1966 University of Iowa. Worked as a technician in the VA Hospital Radioisotope Service Whole Body Counter. Worked two years one-half time and one year full time performing low level gamma counting on patient specimens and processing whole body count data.

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John M. Nocerino

Chemist
Quality Assurance Research Branch

EDUCATION:

Ph.D. Candidate: The Johns Hopkins University, Baltimore, MD; 1976-1982; major: organic chemistry; minor: biochemistry; leave of absence: May, 1982.

Master of Arts: The Johns Hopkins University, Baltimore, MD; October, 1978; major: organic chemistry; minor: biochemistry.

Bachelor of Science: Loyola College, Baltimore, MD; May, 1976; major: chemistry; minor: physics.

Continuing Education:

9/84	Fundamentals of Gas Chromatography
4/85	Statistics and Experimental Design for Cost-Effective Research
8/87	Electrochemical Engineering
7/88	Basic Principles of Mass Spectrometry Interpretation
8/13-18/88	Project Officer Certification Program
9/26-30/88	Contract Administration
3/8-10/89	Applied Multivariate Methods Using Popular Statistical Computing Packages
8/7-9/89	Sampling Methodologies for Monitoring the Environment - Theory and Practice
12/5-6/89	Effective People Skills
1/29-2/1/90	CADRE Course
2/21-23/90	Toxicology for Chemists
6/90	Federal Hazard Communication Training Program
11/26-28/90	Fundamentals of Experimental Design
3/6-8/91	Environmental Regulations Course
6/17-19/91	Pierre Gy Sampling Theory and Practice
9/17/91	Paradox I
10/1/91	Paradox II
11/4-5/91	Sequential Simplex Optimization
11/20/91	Experimental Design in Action
1/15-17/92	Pierre Gy Sampling Theory and Practice
4/21-22/92	Assistance Agreement and Interagency Agreement Training
6/19/92	Recertification of Contract Managers
2/2-5/13/93	Computational Chemistry
3/22-24/93	Multivariate Data Treatment
7/21/93	Federal Hazard Communication Training Program
8/3-5/93	Technical Writing
8/24-26/93	Introduction to Statistics
8/30-9/1/93	AMIR II
9/2/93	Ethics
12/3/93	Radiation Safety Training

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PROFESSIONAL EXPERIENCE:

United States Environmental Protection Agency
Environmental Monitoring Systems Laboratory - Las Vegas
944 E. Harmon Avenue, Las Vegas, NV 89119
Employment: July, 1988, present.
Title: Chemist, Quality Assurance Research Branch.
Current Research Interests: Application of robust statistics and outlier identification to environmental analytical and quality assurance data; statistical experimental design and optimization strategies; multivariate data analysis of environmental analytical and quality assurance data; application of Pierre Gy sampling theory to laboratory subsampling and improvement of performance measurements used in quality assurance practices.
Duties: Chemometrician and quality assurance specialist. Apply existing chemometric and statistical techniques to, or develop novel chemometric and statistical methods and software for, quality assurance research and analytical methods development. Present and participate in workshops and symposia on chemometrics, statistics, sampling theory and quality assurance. Assign and direct research, as well as manage resources and contracts, in chemometric applications to quality assurance, sampling and performance measurements. Supervisory experience.

Work Assignment Manager for Job Order 70.38 under EPA Contract 68-CO-0049 to Lockheed Environmental Systems & Technologies Company, "Chemometric Support to Superfund Quality Assurance" and "Performance Measurement Research."

Project Officer for the University of Houston Cooperative Agreement (EPA Project Control No. CR817552), "Chemometric Approaches to Analytical Methods Development and Application."

Project Officer for the Louisiana State University Cooperative Agreement (EPA Project Control No. CR816008), "Co-ordinate Application of Rapid Toxicity Assay Systems and Field Deployable Analytical Systems for On-Site Monitoring and Prioritization of Hazardous Waste Sites."

Project Officer for the University of Illinois at Chicago Cooperative Agreement (EPA Project Control No. CR815379), "Multivariate Methods for the Analysis of Complex Quality Assurance and Environmental Samples."

Participated in the Quality Assurance Materials Bank and the Sample Container Repository Contract.

Served as a Property Officer for the Quality Assurance and Methods Development Division.

Pacific Engineering and Production Company
Henderson, NV
Employment: February, 1984, to May, 1988.
Title: Research Chemist.
Duties: Development of analytical methods, both in organic and inorganic chemistries, as applies to company products; general research and development relating to the electrochemical production of ammonium perchlorate and its intermediates and in their uses, and also in the odor-control industry; plant environmental and hygienic monitoring of lead and sulfur compounds; plant and manufactured product problem solving and chemical trouble shooting; specify material and equipment purchases; maintain chemical instrumentation and equipment; supervisory experience over several chemical technicians.

Valley Hospital
Las Vegas, NV
Employment: August, 1982, to January, 1984.
Title: Pharmacy Technician
Duties: computer entry; in charge of hard-copy data; prescriptions and formulations; intravenous admixtures.

The Johns Hopkins University
Baltimore, MD
Employment: June, 1976, to May, 1982.
Title: Research Assistant; Teaching Assistant
Duties: Twelve semesters teaching experience in general, organic physical-organic and advanced organic chemistries; private tutoring. Independent research in synthesis, donor-complexing and electromagnetic studies of novel acceptors for organic conductors and semi-conductors; suicide inhibitor affinity-labeling, using radioisotope, ^{14}C, by carbonium ions generated within the active sites of enzymes; synthesis and deamination studies of N-nitroso-N-1-norbonylcarbamate.

Loyola College
Baltimore, MD
Employment: January, 1973, to May, 1976.
Title: Research Assistant
Duties: Independent research: colorimetric determination of alpha-diketones present in blood; medicinal chemistry research in the synthesis of antihistamines, anesthetics and antileukemics (in cooperation with Burroughs-Wellcome and the National Cancer Institute); design of a semester-long experiment for the organic laboratory course.

ANALYTICAL EXPERIENCE:

Spectroscopic: Infra-red (Perkin-Elmer, Models 427 and 659); ultra-violet/visible (Beckman; Bausch & Lomb Spectronic 2000); NMR (Varian, Models T-60 and A-60; Jeol-100); mass spectroscopy (Hitachi 6E-RMU; also, very limited experience with FAB); optical rotation; refractive index; scintillation counting (^{14}C); atomic absorption/flame emission (Jarrell-Ash Atomsorb 82-270).

Separation Techniques: gas chromatography (Varian Models 900, 1860 and 3300) with computer data system (Appligration); GC/mass spectroscopy; HPLC (Waters; limited experience); TLC; column chromatographies, including flash chromatography; amino-acid analyzer (limited experience); vacuum distillation.

Other: autoradiography; ion-selective electrode analyses; trace metal analyses; basic wet chemical methods of separation and identification in organic and inorganic chemistries; some glass blowing (mini-course) and instrumental maintenance experience.

HONORS AND AWARDS:

Alpha Sigma Nu (National Jesuit Honor Society), May, 1976.
McNeil Chemistry Medal, May, 1976.
Phi Lambda Upsilon (National Honorary Chemical Society), September, 1976.
Outstanding American Hero Award, May 30, 1988.
EPA Special Achievement Award, 1989.

LICENSES AND CERTIFICATIONS:

State of Nevada Certificate for Educational Personnel, 1983.
EPA Project Officer Certification, August, 1988.
EPA Contract Manager Certification, September, 1988.

PROFESSIONAL ASSOCIATIONS:

The American Chemical Society.
International Chemometrics Society (Founding Member of the North American Chapter).
The American Statistical Association.

Jeffre C. Johnson
Research Chemist
235 Nebraska
Henderson, Nevada 89015
(702) 798-2177

Employment History/Duties

- U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-las Vegas, Research Chemist, 9/91-present. Current duties include development of immunochemically based assays for organic environmental contaminants such as pesticides and organochlorine compounds. Development utilizes C-14 and H-3 labeled analogues as tracer compounds for extraction and recovery studies.

- U.S. Dept. of Agriculture/Agricultural Research Service/Western Human Nutrition Research Center, Chemist, 6/88-9/91. Served as laboratory manager of the "Bioanalytical Support Laboratory", an in-house analytical chemistry lab responsible for providing chemical analyses in support of the on-going research. Duties included methods development, particularly radioimmunoassay (RIA) for prostaglandins and inductively coupled plasma (ICP) spectroscopy methods for trace metals in biological matrices. Supervised routine RIA for various biomolecules, typically involving C-14, I-125, Co-57, and H-3.

- Tucson Water, City of Tucson, Arizona, Chemist, 10/87-2/88, Limited Term Employment., Developed methodology for spatial mapping of gas-phase trichloroethylene concentration surrounding a water well air-sparge tower, based upon electron capture detection gas chromatography.

EDUCATION/TRAINING

- University of Illinois at Urbana-Champaign, M.S. Chemistry 1987, GPA 4.00/4.00 Honors: Amoco Industrial Fellow
- University of Wisconsin-Madison, B.S. Chemistry 1983, B.A. Psychology 1981 GPA: 3.87/4.00 Honors: American Chemical Society Undergraduate Award in Analytical Chemistry, Ingersoll Award in Physics-Dept. of Physics, Dean's List, Graduated with Distinction.
- U.S. Army Radiation Safety Course: "Safe Handling and Use Of Radioisotopes" 6/89, Letterman Army Institute of Research
- American Chemical Society Short Course: "Effective Management of Chemical Analysis Laboratories", 9/88
- U.S. Office of personnel Management Course: "Introduction To Supervision", 9/88, OPM Training Center, San Francisco, California

Publications

- Superfund Innovative Technology Evaluation (SITE) of Immunoassays for BTX Screening in Water and PCB Screening in Soil, in "Proceedings of the 1993 U.S. EPA/Air and Waste Management Association International Symposium on Field Screening Methods for Hazardous Wastes and Toxic Chemicals," Vol. 2, p. 870-881., Presenter, 2/92.

- Environmental Applications of Immunochemical Methods, Jeannette Van Emon, Jeffre C. Johnson and Kim R. Rogers, presented at the 1992 Pacific Conference on Chemistry and Spectroscopy.

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CURRICULUM VITAE

Jeanette M. Van Emon, Ph.D.

EDUCATION:

California Concordia College; major Education; A.A., 1972

California State University, Hayward; major Environmental Studies; minors Entomology, Biology, Chemistry and Political Science; B.S. 1975

University of California, Davis; Department of Environmental Toxicology; Agricultural and Environmental Chemistry, Ph.D. 1987

RESEARCH INTERESTS:

Development of immunochemical methods including immunoassay and immunoaffinity techniques; development of synthetic antibodies; fate and transport of pesticides in the environment; and the toxicity of natural products.

PROFESSIONAL EXPERIENCES:

1979-1980 Laboratory Helper, University of California, Davis (work involved performing and developing toxicity assays)

1980-1985 Graduate Student Assistant, University of California, Davis (work involved the use of radiolabeled tracers for development of immunoassay and gas chromatography methods for pesticides)

1985-1987 Post-Doctoral Researcher, University of California, Lawrence Livermore National Laboratory (work involved monoclonal antibody production, organic synthesis, and immunoassay development)

1987-present Research Molecular Biologist, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada (work involves the use of radiolabeled tracers for immunoassay development)

HONORS AND AWARDS:

USDA Western Region Pesticide Impact Assessment Program Award (1982-1984)

Proctor and Gamble Fellowship (1983)

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University of California, Davis, Chancellor's Patent Fund (1983)

University of California, Davis, Jastro Shields Award (1982)

Stauffer Chemical Fellowship (1981)

California Graduate Fellowship (1980-1983)

Dean's List and Honor's List, California State University, Hayward, California

U.S. EPA Special Achievement Award (1988)

U.S. EPA Special Achievement Award (1989)

U.S. EPA Special Achievement Award (1990)

U.S. EPA Bronze Medal (1991)

U.S. EPA and American Chemical Society joint Science Achievement Award in Chemistry (1992)

PROFESSIONAL SOCIETY ACTIVITIES:

American Chemical Society (ACS) member (1982 - present). Elected member of the Executive Council and the Biotechnology Committee for the Agrochemical Division of the ACS.

Association of Official Analytical Chemists (AOAC) member (1985 - present). Assisted in immunoassay training workshop at 1991 national meeting of the AOAC.

Curriculum Vitae

Gregg D. Dempsey, Chief
Field Studies Branch
Office of Radiation and Indoor Air
Las Vegas Facility

Education

University of Mississippi, B.A., 1978.
Double major in physics and zoology.

Work Experience

June 1989 to present:

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Las Vegas, Nevada
Chief, Field Studies Branch

Manage ORIA mobile laboratory response, recommend field studies, recommend radioanalyses, manage and direct data quality reviews. Assist EPA Region Superfund, RCRA, Federal Facility, and Radiation Programs Offices by providing radiation and health physics consulting services. Managed and direct the Las Vegas Facility's emergency and Superfund response. Serve as a senior member of ORIA emergency response staff in nuclear weapons, nuclear power plant, and other type of Federal response for incident and accident exercises.

Oct. 1987 to June 1989:

U.S. Environmental Protection Agency
Office of Radiation Programs
Las Vegas, Nevada
Environmental Scientist, Field Studies Branch

Served as Office of Radiation Programs - Las Vegas Emergency Response Coordinator. Duties included assessing condition of response readiness, recommending improvement where needed, and meeting with other groups in the federal government concerning emergency preparedness exercises dealing with accidents at commercial nuclear power plants and nuclear weapons accidents.

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Nov. 1980 to
Oct. 1987: Mississippi State Department of Health
Division of Radiological Health
Environmental Monitoring and
Emergency Response Branch
Branch Director

Managed radiation laboratory that was responsible for Safe Drinking Water analysis for the state. Directed section responsible for environmental monitoring around nuclear facilities, former DOE sites, ambient radiation measurement in air due to fallout, and radioanalysis of community drinking water supplies within Mississippi. Emergency functions included response to nuclear incidents at nuclear power plants, transportation accidents, and elsewhere.

June 1979 to
June 1981: Mississippi State Board of Health
Division of Radiological Health
Health Physicist I/III

In Environmental Section, developed and maintained environmental monitoring at Grand Gulf Nuclear Station which included collection and analysis of various samples representative of the environment. Assisted in analysis and report preparation of the 1600 community drinking water supplies in Mississippi in accordance with the Safe Drinking Water Act.

Professional Associations:

- Health Physics Society
- Conference of Radiation Program Directors

Additional Training:

- Nuclear Regulatory Commission 10-Week Health Physics Course, Oak Ridge Associated Universities, 1980.
- Environmental Protection Agency Laboratory Radioanalysis of Public Drinking Water Supplies Course, Georgia Institute of Technology, 1982.
- Department of Energy Radiological Monitoring, Sampling and Analysis Course, Idaho National Engineering Laboratory, 1984.
- Department of Energy Fundamentals of Health Physics Review Course, DOE Nevada Operations Office, 1988.
- Additional Course Listings on Request.

Legal Recognition:

Accepted as radiation laboratory and environmental health physics expert by the litigants in the Street, Inc. v. Chevron, et. al. , 1991 legal case. This case concerned laboratory data, laboratory analyses, and data validation issues.

COLLEEN F. PETULLO
4516 La Madre Way
North Las Vegas, NV 89117
(702) 645-4198

EDUCATION:

University of Nevada, Las Vegas
MS, Adult/Technical Education
May 1989

Memphis State University, Memphis, TN
Nuclear Reactor Fundamentals Certificate
July 1982

University of Lowell, Lowell, MA
BS, Health Physics
May 1978

LICENSES AND CERTIFICATIONS:

1987	American Board of Health Physics Certification, Part I.
05/85 - Present	Department of Energy "Q" Level Security Clearance
05/24/77 - 05/24/81	Nuclear Reactor Operator License (#4453)

PROFESSIONAL EXPERIENCE:

3/91 to Present

Health Physicist: U.S. Public Health Service detailed to U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV
Responsibilities: Manage, promote and direct radioanalytical laboratory for superfund and federal facility site assessments and remediation projects. Manage and direct quality assurance activities of field studies branch. Project Officer for technical and analytical contracts. Senior member of EPA's radiological Emergency Response Team. Provide audits, review and advice to EPA, other federal agencies and governments on procedures for radiation measurement, evaluation and analysis; Prepare technical reports, publish findings and present papers at scientific conferences and meetings.

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PROFESSIONAL EXPERIENCE (Cont'd):

12/89 - 3/91 **Health Physicist:** U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, NV
Responsibilities: Senior member of EPA's radiological emergency response team; Project Officer for analytical and technical contracts; Provide review and advice to EPA, other federal agencies and state governments on EPA procedures for radiation measurement, evaluation and analysis; Review and evaluate environmental monitoring data for purposes of setting environmental radiation standards; Prepare technical reports, publish findings and present papers at scientific conferences/meetings.

08/89 - 10/89 **Health Physics Consultant (On-Loan):** University of Nevada, Reno (UNR), Reno, Nevada. (UNR requested my services through the Department of Energy, Nevada Operations Office.)
Responsibilities: Reviewed UNR's overall Health Physics operations and made recommendations for radiation safety and cost effectiveness improvements. Wrote a new Radiation Safety Guide including operating procedures for their 2 MeV Van deGraaff and 150 KeV proton accelerators. Prepared the Type B, Broad Scope, license application for submission to State of Nevada, Radiological Health Department.

09/84 - 12/89 **Health Physicist/Training Programs Director:**
Reynolds Electrical & Engineering Co., Inc., Nevada Test Site, Mercury, NV
Responsibilities: Managed the development, execution, evaluation, administration and marketing of training programs for;

- The Health Physics, Industrial Hygiene and Defense Low Level Radioactive Waste Departments
- The Radiation Health Program, Nevada Test Site Practicum for the University of Nevada, Las Vegas.
- Radiological Emergency Response Training for local, state and federal personnel for the U.S. Department of Energy and the Federal Emergency Management Agency. Served as the Training Section's Quality Coordinator with specific expertise in ANSI/ASME NQA-1. Served as the Chairperson of the Health Physics Department Training Advisory Committee.

PROFESSIONAL EXPERIENCE (Cont'd):

10/83 - 09/84 **Radiological Safety and Radiological Instrument Sections Supervisor:** New Hampshire Emergency Management Agency, Concord, NH

- Assisted in the formulation and establishment of Agency policies, goals, and objectives that had statewide, as well as interstate ramifications.
- Prepared technical reports and papers for presentation/publication.
- Represented the Agency at professional, public and government meetings.
- Managed teams that evaluated contractor quality.
- Planned for the utilization of the Section(s) budget resources, including fiscal management, personnel management, budget analysis and preparation.
- Developed and evaluated the statewide radiological protection system for day-to-day and emergency conditions.

03/80 - 09/83 **Nuclear Reactor Control Room Operator:** Public Service Company of New Hampshire, Seabrook Nuclear Power Plant, Seabrook, NH

- Participated in the development of the Operations Department Operating and Emergency Procedures.
- Participated in training in preparation for a Nuclear Regulatory Commission, Reactor Operator Licensing Exam.
- Performed system(s) start-up and operational checks.

12/76 - 09/79 **Nuclear Reactor Control Room Operator:** University of Lowell, Lowell, MA

- Operated the reactor and all its appurtenances, including the reactor control systems, cooling system, reactor bridge, reactor pool, all experimental systems associated with the reactor, reactor building ventilation system and cooling system clean-up systems. Conducted Nuclear Engineering and Health Physics Department reactor operations labs.

PROFESSIONAL EXPERIENCE (Cont'd):

PAPERS:

1. **"The Mobile Scanner Van Reports for Duty"**, U.S. Environmental Protection Agency Journal (nee; EPA Journal), Volume 18, Number 2, May/June 1992.

1. **"Comparison of Alpha Track Detectors vs A Radon-222 Continuous Gas Monitor to Monitor Radon-222 In Mine Ventilation Air Released From An Active, Underground Uranium Mine"**, U.S. Environmental Protection Agency, Office of Radiation Programs Report. Presented at the Radon Technical Exchange Conference, June 19-20, 1991, Denver, CO.

2. **"A Curriculum Model For Nevada Test Site Radiation Protection Technician Training"**, a Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Adult/Technical Education, 1989.

3. **"Radiological Emergency Response Training - The Trainer's Perspective"**, presented at the 12th Annual TRADE Conference, 1988, San Francisco, CA and 1987 Health Physics Society Midyear Topical Meeting on Power Reactor Health Physics, Miami, FL.

4. **"Pre-Employment Job Orientation Seminar - After Two Years"**, presented at the 11th Annual TRADE Conference, 1987, Atlanta, GA.

PROFESSIONAL ACTIVITIES:

1. Associate member of the American Board of Health Physics.

2. Serving on Membership Committee, National Health Physics Society (1991-1993).

3. Member of the Lake Mead Chapter of the Health Physics Society.

PERSONAL: Speak, read and write French (Canadian Dialect)
Married, one child

REFERENCES: Will be furnished upon request.

Richard D. Hopper
5177 Sunnywood Drive
Las Vegas, Nevada 89120

Manage and direct EPA's Office of Radiation and Indoor Air as Vegas (ORIA-LV) Radon and Indoor Air Programs. Provide technical support to Headquarters Radon and Indoor Air Divisions, EPA Regional Offices, other Government Agencies, State Health Departments, and International Agencies. Directs large National radon and indoor air surveys documenting results in reports and at appropriate meetings. Established and directs a National program for evaluating new radon and radon decay product instrumentation. Mentor students and professionals from high schools, universities, and foreign countries. Travel outside the U.S. to lecture and train professional personnel on radon measurement, detection, and mitigation.

EXPERIENCE

1989 to Present — U.S.Environmental Protection Agency, Las Vegas, Nevada
Branch Chief
Chief of the Evaluation Branch for EPA's Office of Radiation and Indoor Air Laboratory in Las Vegas, Nevada. The Branch operates three environmental radon chambers and develops methods and procedures for the measurement of radon, evaluates radon instrumentation, and develops indoor radon measurement protocols. The Branch also has an indoor air program and conducts ventilation measurements in large buildings and schools. Manage and supervise a professional staff of health physicist, engineers, chemist, and geologist. Work assignment manager for ORIA-EPA contracts and cooperative agreements with universities. Duties include contract management, budget planning, recruiting, interviewing, hiring, writing and evaluating job descriptions. Handle employee problems and interface with personnel office. Have current U.S. Department of Energy "Q" clearance.

1970 to 1989 — U.S.Environmental Protection Agency, Las Vegas, Nevada
Environmental Scientist
Project officer for emergency response team, thermoluminescent dosimetry (TLD) program manager, and lead scientist for the Office of Radiation Program Las Vegas Radon Program. Developed and designed the Las Vegas Radon Program and Radon Laboratory. Supervised other professionals, technicians, university students and prepared annual budget for the above programs. Versed in all types of radiation detection equipment, sources, and decontamination procedures.

EDUCATION

Bachelor of Science Degree
September 1985 to June 1989
Major: Health Physics

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PROFESSIONAL SKILLS

Contract management and computer skills

Have completed EPA contract manager courses; currently the Work Assignment Manager on the ORIA-LV GSA computer contract, and Sandy Cohen & Associates contract for the EPA School Ventilation Improvement Project. In addition, work assignment manager for cooperative agreements with University of Nevada Las Vegas and University of Tulsa to provide indoor environmental measurements, conduct building heating ventilation and air conditioning (HVAC) characterization, and building occupant questionnaires. Have extensive knowledge of computers; hardware and software applications. Expanded word processing skills and good statistical program knowledge.

PROFESSIONAL SOCIETIES

National Health Physics Society
June 1985

American Nuclear Society
June 1985

COMPUTER EXPERIENCE

Machines: 486 micro computer and Vax central computers. Primary use includes contracts, reports, and WP.

Programs: Windows, WordPerfect, and Excel are used daily.

AWARDS & HONORS

-Gold medal for response to the Three Mile Island Accident

-Bronze Medal for the Radiological Safety Program at the Nevada Test Site

-Bronze Medal for Revising and Improving EPA's Radon Measurement Proficiency (RMP) Program

-Bronze Medal for EPA's Radon Measurement Proficiency Program

-Department of State Award for on-the-scene evaluation for the Chernobyl Nuclear Accident for Americans stationed in Eastern Europe

-Bronze Medal for designing and implementing a national measurement survey to determine the average ambient outdoor radon levels in the United States

REFERENCES

Available upon request.

GREGORY J. BUDD

EXPERIENCE:

Health Physicist 1991-Present
U.S. EPA
Office of Radiation and Indoor Air
4220 Maryland Parkway, Bldg C.
Las Vegas, Nevada 89119

Responsible for overseeing the daily operations of the ORIA-LV environmental radon laboratory. Additional duties include serving as the Branch quality assurance coordinator, managing the national Radon Measurement Proficiency Program, performing technical reviews of National and International scientific papers/projects involving environmental radiation being performed by the Branch, and serving as the alternate radiation safety coordinator for the Branch.

Adjunct Faculty 1993
University of Nevada Las Vegas
Department of Radiological Sciences
4505 Maryland Parkway
Las Vegas, Nevada 89154

Instructed a required course in radiation science and safety for students enrolled in the programs of nuclear medicine and radiography. Course material covered basic principles of radiation physics and safety. Emphasis was placed on radiation hazards and appropriate safety practices typically encountered within a clinical setting.

Environmental Scientist 1989-90
U.S. EPA
401 M Street, S.W.
Washington, D.C. 20460

As an Environmental Scientist for the Office of Compliance Monitoring, Case Support Branch, I was responsible for providing scientific and technical guidance, regional coordination, and legal enforcement for TSCA, FIFRA, and EPCRA.

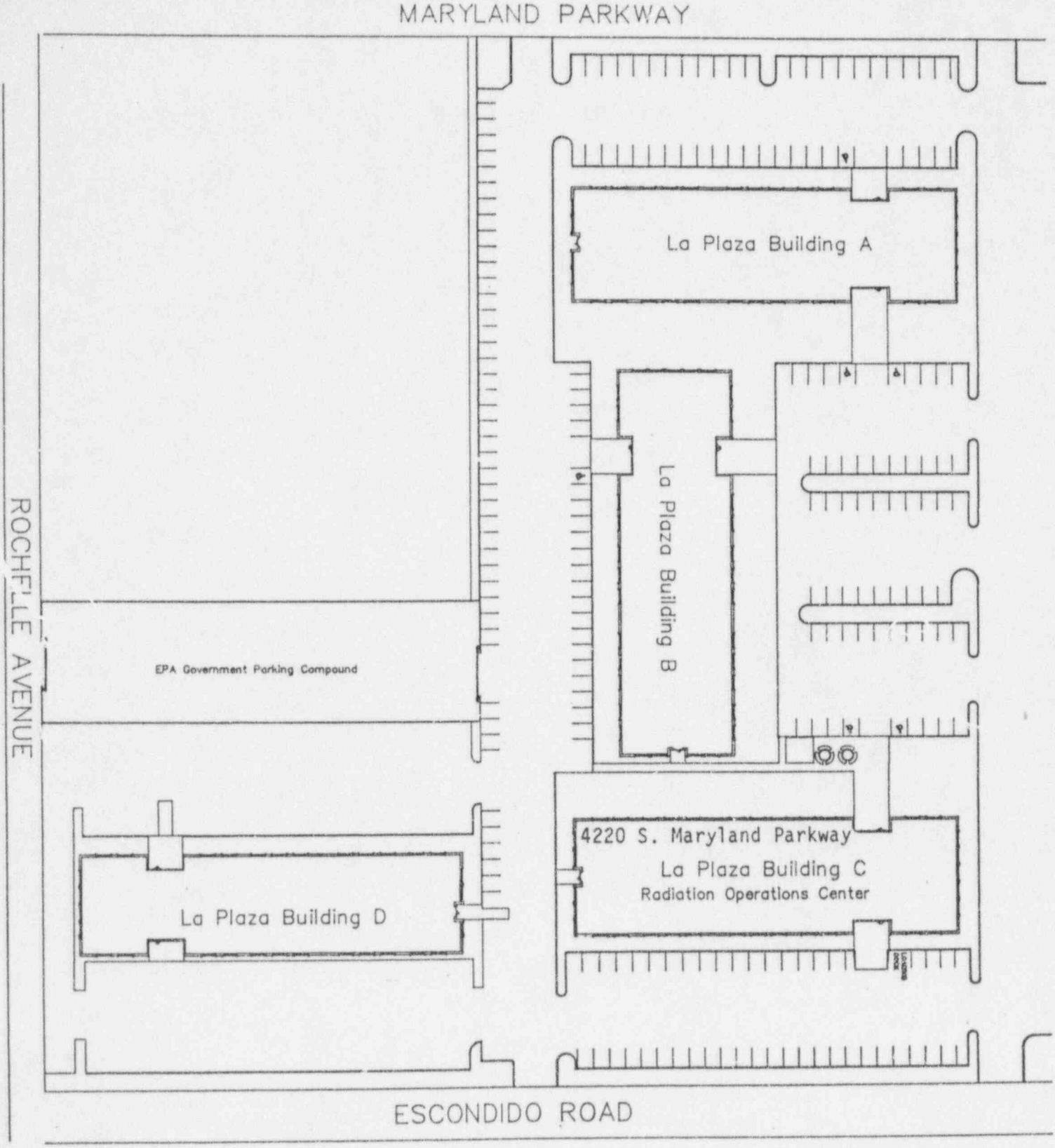
Physicist 1987-89
Department of Defense
Naval Surface Warfare Center
Dahlgren, Virginia 22448

As a Physicist for the Weapon Systems Department, I served as a Project Engineer and Analyst.

EDUCATION:

B.S. Cum Laude Biology and Physics
Mary Washington College
Fredericksburg, Virginia - 1986

Encl #22



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Encl #23

DOELAP

United States Department of Energy
Laboratory Accreditation Program
for Personnel Dosimetry Systems

DOELAP

Certificate of Accreditation

EPA ENVIRONMENTAL MONITORING SYSTEMS LABORATORY

is recognized for demonstrating compliance with DOE performance criteria for personnel dosimetry systems. Accreditation is granted for the dosimetry systems and irradiation categories specified in the conditions of accreditation.

September 1, 1991

Effective date

Robert M. Loesch

DOE Laboratory Accreditation
Program Administrator

Encl #24

CONDITIONS OF DOELAP ACCREDITATION

EPA ENVIRONMENTAL MONITORING SYSTEMS LABORATORY

The whole body personnel dosimetry system described below that is used by EPA Environmental Monitoring Systems Laboratory is granted DOELAP accreditation. Accreditation status is effective until September 1, 1993.

Dosimeter Identification: Panasonic UD-802 dosimeter insert and holder.

Reader System: Panasonic UD-710A automated reader system and UD-730 automated TLD changer.

DOELAP Categories:

I.	Low-energy photons, high dose levels
II.	High-energy photons, high dose levels
III.A	Low-energy photons, general
IV.	High-energy photons
VII.	Mixture category, IIIA + IV

Accreditation is for this dosimeter and reader system only, and is contingent upon maintaining dosimetry practices that are consistent with the methodologies used during DOELAP performance testing and the onsite assessment. Re-accreditation of your dosimetry system will be necessary every two years as required by DOE 5480.15 and as discussed in the DOELAP Handbook (DOE/EH-0026).

United States
Environmental Protection
Agency

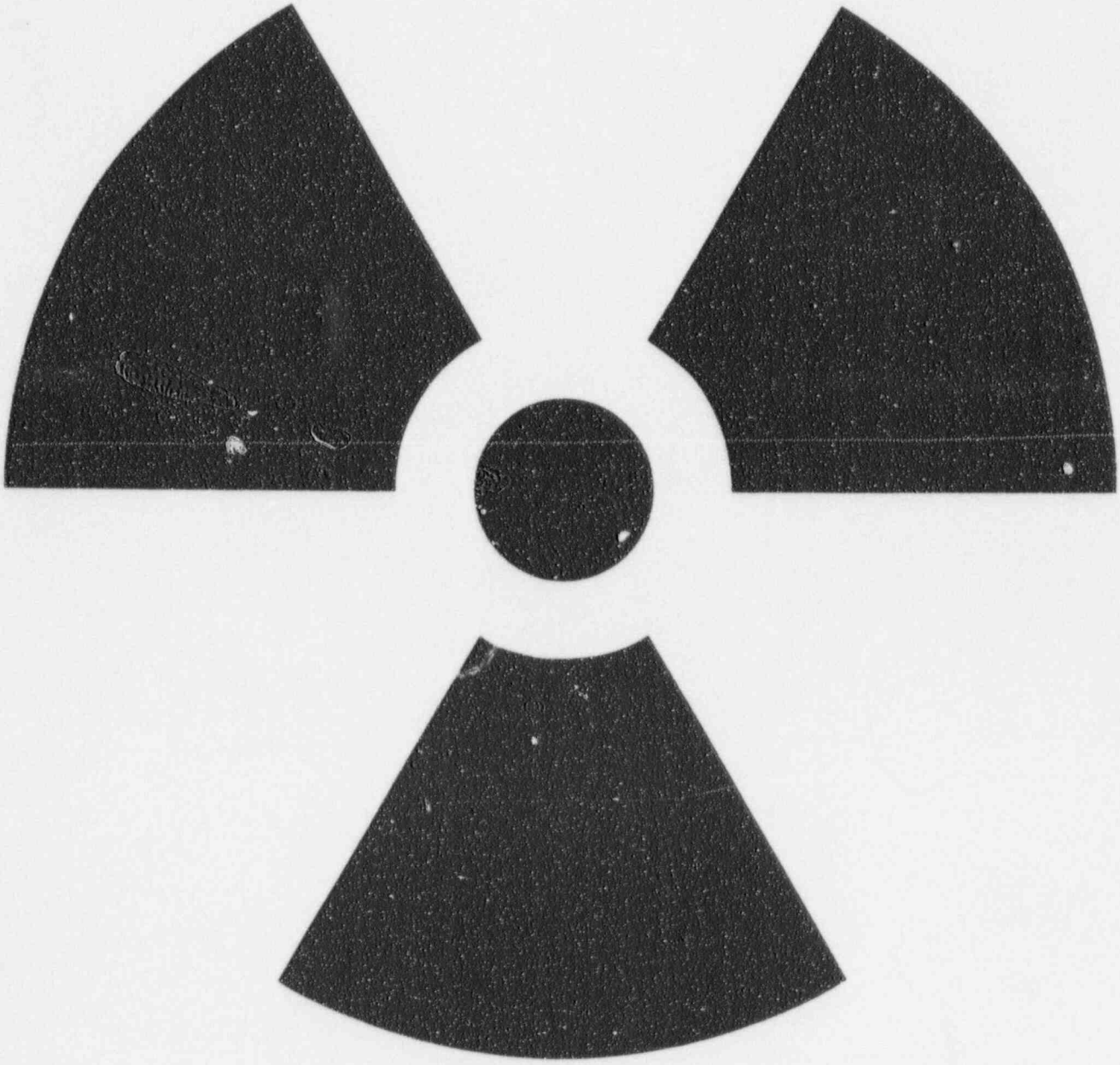
Environmental Monitoring
Systems Laboratory
P.O. Box 93478
Las Vegas NV 89193-3478

February 1994

Research and Development

EPA

Radiation Safety Manual



Encl #25
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RADIATION SAFETY MANUAL

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FOREWORD

Users of this Radiation Safety Manual are encouraged to recommend changes. Comments should be sent directly to the Radiation Safety Officer and should be keyed to the specific page, paragraph, line of the text for each recommended change and the reasons provided to ensure understanding and complete evaluation.

This manual has been approved by the EMSL-LV Radiation Safety Officer, Radiation Safety Committee, Laboratory Director and the Director, Office of Radiation and Indoor Air (ORIA).

APPROVED:

Loyd D. Carroll — 11 FEB 94

Loyd D. Carroll
Radiation Safety Officer

Date

Donald M. Daigler, Chairperson — 2/11/94

Radiation Safety Committee

Date

Wayne N. Marchant — 2/11/94

Wayne N. Marchant
Director, EMSL-LV

Date

Jed Harrison — 2/11/94

Jed Harrison
Director, ORIA

Date

The U.S. Environmental Protection Agency (EPA) through the Office of Research and Development developed the plan described herein. It is intended for internal EMSL-LV use only. The mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This manual supersedes EMSL-LV's Radiation Safety Manual, dated December 1988.

A. INTRODUCTION. The U.S. Nuclear Regulatory Commission (NRC) has issued to the U.S. Environmental Protection Agency (EPA), Office of Research and Development, Environmental Monitoring Systems Laboratory (EMSL), Las Vegas (LV), Nevada, a radioactive materials license for the procurement, receipt, possession, usage, storage, transfer, disposal, shipment and transportation of radioactive materials and sources of ionizing radiation.

1. PURPOSE. The purpose of this manual is to:

a. Implement applicable laws, regulations, conditions, and restrictions under which radioactive materials and equipment that produces ionizing radiation are used;

b. Promulgate the rules, direction, and guidance of the Radiation Safety Committee in the proper and safe handling of radioactive material and equipment that produces ionizing radiation;

c. Control the procurement, receipt, possession, usage, storage, transfer, disposal and shipment of radioactive material and equipment that produces ionizing radiation; and

d. Prescribe the Radiation Safety Program for EMSL-LV.

2. SCOPE. This manual applies to all individuals, organizations, activities, co-located units, contractors and subcontractors, etc., using radioactive materials and sources of ionizing radiation licensed to and used at EMSL-LV.

3. POSTING OF NOTICES TO WORKERS.

a. Current copies of the following documents shall be conspicuously posted in a sufficient number of places to permit individuals engaged in licensed activities to observe them on the way to or from any particular licensed activity location to which the document applies and shall be replaced if defaced or altered:

(1) EMSL-LV's NRC license, license conditions, or documents incorporated into the license by reference, and all amendments;

(2) Title 10, Code of Federal Regulations (10 CFR), Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations" and Part 20, "Standards for Protection Against Radiation;"

(3) The operating procedures applicable to licensed activities, i.e., EMSL-LV's Radiation Safety Manual;

(4) Form NRC-3, "Notice to Employees"; and

(5) Any notice of violation involving radiological working conditions, proposed imposition of civil penalty or order issued by the NRC and EMSL-LV's response. These shall be posted within 2 working days after receipt (or dispatch) and remain posted for a minimum of 5 working days or until action correcting the violation has been completed, whichever is later.

b. If posting of those documents in paragraph A3a(1)-(3) is not practicable, then a "notice" which describes the documents and states where the documents can be examined will be posted.

c. All the above documents are available for review and are located in the office of the Radiation Safety Officer (RSO), 4220 South Maryland Parkway, La Plaza C building, Radiation Operations Center (ROC) room 609, phone (702) 798-2313.

4. EXPLANATION OF TERMS.

a. Will/shall. Infers a standard, condition, or procedure which must be met for one to be in compliance with punitive rules and regulations.

b. Should. Infers a standard, condition, or procedure from which one may deviate for good and sufficient reason without violating a punitive regulation. Decisions to deviate from the accepted procedures in this manual warrant careful consideration by the Authorized User or other responsible individual in a supervisory capacity.

c. He. Represents both the masculine and feminine.

B. RESPONSIBILITIES. The Laboratory Director, EMSL-LV, has overall responsibility for the Radiation Safety Program and will establish a Radiation Safety Committee and appoint a Radiation Safety Officer to ensure that the requirements in this manual, EMSL-LV's NRC license, amendments, associated documents and NRC rules and regulations are implemented, followed and enforced.

1. RADIATION SAFETY COMMITTEE (RSC). As an advisory body to the Laboratory Director, the RSC is responsible for the administration and enforcement of EMSL-LV's radiation safety program to ensure that radioactive materials and sources of radiation are used safely and that radiation exposures to workers and the public are maintained at levels that are As Low As Reasonably Achievable (ALARA).

a. Membership of the RSC consists of a representative from management, the Radiation Safety Officer, EMSL-LV Safety, Health and Environmental Manager (SHEM), persons trained and experienced in the safe use of radioactive materials and other personnel deemed as appropriate. Appointments are made by the Laboratory Director.

b. The RSC shall:

(1) Be familiar with the subject matter in this manual, applicable NRC rules and regulations, the NRC license, amendments and all associated documents;

(2) Establish and implement written policy and procedures for the production, procurement, receipt, possession, storage, usage, transfer, disposal and shipment of radioactive materials and equipment that produces ionizing radiation;

(3) Review the training and experience of the proposed authorized users and the Radiation Safety Officer (RSO) to determine that their qualifications are sufficient to enable the individuals to perform their duties safely and are in accordance with applicable regulations and the license;

(4) Review on the basis of safety and approve or deny, consistent with the limitations of applicable regulations, the license and the ALARA philosophy, all requests for authorization to use radioactive materials;

(5) Prescribe special conditions that will be required during a proposed method of use of radioactive material such as, but not limited to, requirements for bioassay and special monitoring procedures;

(6) Establish a training and educational program to ensure that all individuals working in or frequenting an area where sources of ionizing radiation are used or stored are instructed as required by 10 CFR Part 19, Section 19.12;

(7) Review the RSO's quarterly summary report of the occupational radiation exposure records of all personnel and establish occupational exposure investigational levels which, when exceeded, will initiate a prompt investigation by the RSO to determine the cause of the exposure and, if required, initiate corrective action to reduce the probability of recurrence;

(8) Review at least annually the RSO's summary report of the entire radiation safety program to determine that all activities are being conducted safely, in accordance with NRC regulations and the conditions of the license, and consistent with the ALARA program and philosophy. The review must include an examination of records, reports from the RSO, results of NRC

inspections, written safety procedures, and the adequacy of the management control system;

(9) Review all incidents involving radioactive materials or other sources of ionizing radiation with respect to the cause and subsequent actions taken; and

(10) Ensure that the NRC license is amended when required, prior to any changes in radionuclides and activities, facilities, equipment, policies, procedures and personnel.

c. Meetings and documentation.

(1) The RSC shall meet at least quarterly and at any other time at the request of the Chairperson or the representative from management.

(2) To establish a quorum and to conduct business, at least one-half of the membership must be present, including the RSO and the representative from management.

(3) The minutes shall be written, dated, and include the attending and absent members, a summary of deliberations and discussions, recommended actions and the numerical ballot results. The minutes shall be provided to each member and one copy retained for the duration of the license.

2. RADIATION SAFETY OFFICER (RSO) or designated Alternate RSO. The RSO has direct access to the Laboratory Director on matters of radiological safety and has the authority to immediately terminate any project that is found to be a threat to health, safety or property.

a. The RSO is responsible for the implementation and enforcement of the Radiation Safety Program. Temporary minor exceptions to specific provisions of this manual may be granted by the RSO on an individual basis, providing such exceptions do not jeopardize individual safety or violate the NRC license, conditions, and associated documents and rules and regulations for the use of radioactive materials or equipment that produces ionizing radiation. The RSC is the final local authority regarding practices, policies or interpretation of any provision of the EMSL-LV [illegible] license.

b. The RSO shall:

(1) Advise the Laboratory Director, RSC, and workers of radiation safety hazards and on the control of radioactive materials and other sources of radiation;

(2) Maintain, as custodian of all radioactive materials, a current inventory of all radioactive materials from

their receipt to their ultimate disposal or transfer;

(3) Ensure that portable survey instruments used for monitoring licensed activities are properly calibrated and maintained in operable condition;

(4) Review all proposed uses of radioactive materials and all Standard Operating Procedures (SOPs) for operations involving radioactive materials prior to their review by the RSC;

(5) Administer and conduct training and educational programs for radiation safety and the usage of radiation sources;

(6) Ensure that radiological surveys, leak testing of sealed sources and checks of safety equipment are performed;

(7) Approve all procurement requests for radioactive materials prior to their purchase, all transfers (in/out bound), disposals and shipments of radioactive materials and waste;

(8) Investigate all radiological incidents and accidents and other deviations from approved radiation safety procedures and implement corrective actions as necessary;

(9) Review on a quarterly basis all occupational radiation exposure records of personnel, promptly perform an investigation when the established exposure investigational levels are exceeded to determine the cause, and if required, initiate corrective action to prevent recurrence;

(10) Brief management once each year on the radiation safety program; and

(11) Maintain a copy of the NRC license and associated documents, each licensing request and amendment, the written policy and procedures, all records and reports required by NRC regulations, and Titles 10 and 49, Code of Federal Regulations.

3. AUTHORIZED USERS OF RADIOACTIVE MATERIALS.

a. Authorized Users and Co-Authorized Users are designated individuals who have been specifically approved by the Radiation Safety Committee (by the issuance of a Radiation Authorization) to procure, use and transfer radioactive materials and equipment that produces ionizing radiation in accordance with the conditions in their Radiation Authorization and this manual.

b. Authorized Users and Co-Authorized Users shall:

(1) Become thoroughly familiar with the subject matter and procedures in this manual before using radioactive materials;

(2) Obtain and use radioactive materials only as authorized by this manual;

(3) Take adequate precautionary measures to protect all personnel and the public from unwarranted exposure to radioactive materials or radiation;

(4) Seek advice and assistance from the RSO when in doubt concerning the safety of an operation;

(5) Prescribe rules, procedures, SOPs or protocols for the use of radioactive materials under his control to ensure proper and safe use. These will be made available to any radiation worker in that area and provided to the RSO when requested;

(6) Ensure that all personnel working with sources of radiation under his authorization or in his area of responsibility receive radiation safety training as required and are knowledgeable in the specific practices and procedures to be followed or avoided in the interest of radiological safety;

(7) Ensure that all rules, procedures, and practices of radiological safety are rigorously followed in their work areas;

(8) Seek the assistance of appropriate supervisors if assistance is required in obtaining cooperation and compliance. Although the RSO is available to provide necessary technical advice on matters of radiological safety, enforcement of the requirements in this manual is the responsibility of the Authorized User and his immediate supervisor. All disputes should be resolved at the lowest possible level;

(9) Promptly report to the RSO any condition which may lead to or cause a violation of NRC regulations, this manual, radiation safety procedures or unnecessary exposure to radiation or radioactive materials, including known or suspected overexposures to radiation, radioactive spills, radiological emergencies, missing or lost sources, etc;

(10) Maintain an accurate and current inventory of the quantity of radioactive material on hand to be readily available to the RSO upon request;

(11) Ensure that radiation monitoring surveys are performed as required and contamination is controlled; and

(12) Be directly responsible to the RSC for violations of this manual by personnel working under his Radiation Authorization. The RSO will report all cases of this nature to the RSC whenever appropriate corrective actions are not initiated by the Authorized User or when violations are repeated or flagrant.

4. INTERNAL/EXTERNAL DOSIMETRY MANAGER. The Internal/External Dosimetry Manager shall:

a. Manage the dosimetry program as required by 10 CFR Part 20, specifically for the summation of external and internal doses (10 CFR 20.1202), determination of prior occupational dose (10 CFR 20.2104), records of individual monitoring results (10 CFR 20.2106) and form of records (10 CFR 20.2110);

b. Immediately notify the RSO when a monitored individual has received a radiation exposure/dose equal to or in excess of those values or limits specified in paragraphs F, G2a, b, I5a, 10 CFR 20.2202(a)(1), (b)(1) and 20.2203(a)(2);

c. Provide to the RSO personnel radiation dosimetry reports on a quarterly basis and when requested; and

d. Inform, in writing, workers of their radiation exposure at least annually and provide workers, when requested, with those notifications and reports required by 10 CFR 19.13.

5. SAFETY, HEALTH AND ENVIRONMENTAL MANAGER (SHEM). The SHEM will coordinate with the RSO and approve the disposal, transportation and shipment of mixed radioactive materials or waste containing hazardous materials.

6. OTHER EMPLOYEES WORKING AT EMSL-LV.

a. All Federal and non-Federal employees whose work site is EMSL-LV will notify their immediate supervisor and the RSO of any radiological condition which can or may cause unnecessary exposure to radiation or a safety infraction.

b. Any worker can bring to the attention of their supervisor, the RSO and RSC any issue or concern related to radiological policy or practice.

C. AUTHORIZATION TO USE RADIOACTIVE MATERIALS. Before an individual can procure, receive or use radioactive materials or equipment that produces ionizing radiation, he must first obtain written approval (a Radiation Authorization) from the RSC to become an Authorized User of radioactive materials.

1. New Radiation Authorization.

a. Individuals are to contact the RSO for procedural and administrative guidance and will:

(1) Be provided a copy of this manual and schedule with the RSO a radiation safety training class for all individuals who will be using the radiation sources;

(2) Prepare one copy of the "Request for Authorization to Use Radioactive Material" form, specifying "New," and complete the requested information in all sections on the front, including the required signatures (excluding the EMSL-LV Radiation Safety Committee Approval section), and back side of the form (pages 12 and 13);

(3) Ensure that all workers, including himself and his Co-Authorized User(s), document their radiation safety training and usage experience on the "Training and Experience of Radiation Worker" form (page 14);

(4) Write Standard Operating Procedures (SOPs) for all proposed usages of the requested radioactive materials, i.e., protocols, research projects, etc. Radiation exposure calculations and literature reports, when applicable, are to accompany protocols; and

(5) Submit all forms, records, documents and SOPs to the RSO, who will review the request for authorization to use radioactive materials prior to its submission to the RSC. The RSO will verify the presence and accuracy of the required information on all documents and ensure that the requested procedures, radionuclides and their activities, etc., are in accordance with this manual and authorized by the NRC license. If additional operating conditions or restraints are required to ensure personnel safety or compliance with regulatory procedures, the RSO will discuss these with the individual, who will incorporate these conditions into his request.

b. The RSO will perform a formal radiation protection survey by completing the "Radiation Safety Evaluation for Use of Radioactive Material" form (page 15) of the proposed use/storage areas to evaluate personnel, equipment and safety requirements.

c. The individual's request with accompanying information and the RSO's radiation protection survey report will be presented to the RSC for review, discussion, approval or disapproval. The RSC will evaluate the request for compliance with regulatory and radiological safety requirements to ensure that exposures to workers and the public are maintained ALARA. If the RSC recommends additional restraints or conditions, the individual will incorporate these into his request.

REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIAL ( ) NEW ( ) REVIEW ( ) AMENDMENT	DATE
THRU: Radiation Safety Officer, EMSL-LV TO: Radiation Safety Committee, EMSL-LV	FROM:
List Co-User(s): List Workers:	
Radionuclides and Maximum Activity of each which may be possessed at any one time (complete backside). ☐ Unsealed Source ☐ Sealed Source	
Areas of Radioactive Material Use	Storage Area:
Description of Use (Use additional sheets if needed)	
I ACKNOWLEDGE MY RESPONSIBILITIES AS PRINCIPAL USER. (Signature of Principal User)	ADMINISTRATIVE APPROVAL: (Signature of Chief of Department, Branch or Division)

EMSL-LV RADIATION SAFETY COMMITTEE APPROVAL			
APPROVED: Radiation Safety Officer	APPROVED: Chairperson, Radiation Safety Committee	AUTHORIZATION NO. DATE	REVIEW DATE

Page 2: REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIAL

Radionuclide	Total Activity Maximum amount	Maximum One Time Use Activity	Physical Form	Chemical Form

TRAINING AND EXPERIENCE OF RADIATION WORKER

1. Name (printed): _____

Date of Birth: _____ SSN: _____ _____

Name of Authorized User: _____

2. Check "yes or no" in Columns I and II for the type of training you have had: if "YES", then complete Columns III and IV and Sections 3 and, if applicable, 4.

Field of Training	I Formal Course		II On-the-job Training		III Location and Dates (mo/yr) of Training	IV Number of hrs, days,etc
	yes	no	yes	no		
Principles and Practices of Rad Safety						
Biological Effects of Radiation						
Mathematics and calculations pertaining to the use and measurement of radioactivity						
Radiation instrumentation and monitoring procedures						
Radiopharmaceutical Chemistry, Radiation Biology, Nuclear/Radiation Physics						

3. Indicate the title and subject matter of each Formal Course.

4. State your experience and use with materials; isotopes, the activities and the reason for usage, where the experience was obtained, and the duration of use.

RADIATION SAFETY EVALUATION FOR USE OF RADIOACTIVE MATERIAL

A radiation safety evaluation will be conducted by the Radiation Safety Officer prior to:

a. Approval of a new radioactive material authorization.
b. Review of an authorization.
c. A change in a current authorization such as isotopes, quantities, rooms, protocols, etc.

1. Authorized User _____ _____ Division/Branch _____

2. Authorized Use Area(s): _____

a.	Work Benches				
	Absorbent paper	Y	N	NA	
	Radioactive material labeling	Y	N	NA	
b.	Waste Receptacles				
	Solid waste	Y	N	NA	
	Liquid waste	Y	N	NA	
c.	Authorized Sink Disposal	Y	N	NA	Room_____ _____
	Disposal log	Y	N	NA	
d.	Fume Hood Required	Y	N	NA	
	Air flow check	Y	N	NA	
e.	Signs				
	Room entrance	Y	N	NA	
	Storage Area	Y	N	NA	
	Waste Area	Y	N	NA	
f.	Shielding	Y	N	NA	

3. Personnel Safety Item Requirements:

a.	Gloves	Y	N	NA
b.	Lab coats	Y	N	NA
c.	Shoe covers	Y	N	NA
d.	Eye protection	Y	N	NA
e.	Respirator	Y	N	NA
f.	Other _____			

4. Instrumentation and Personnel Monitoring Requirements:

a.	Dosimetry (TLD)	Y	N	NA
b.	Bioassays	Y	N	NA
c.	Room monitor	Y	N	NA
d.	Air samples	Y	N	NA
e.	Survey instrument	Y	N	NA
f.	Radiation surveys	Y	N	NA
g.	Contamination surveys	Y	N	NA

5. Additional Comments:

6. ALARA: Based on this evaluation, maximum individual exposures should not exceed _____ millirem per quarter. An investigational exposure limit of _____ millirem per quarter will be used by the Radiation Safety Officer to maintain exposures ALARA.

Evaluation conducted by _____ Date _____

Signature _____

d. Following approval by the RSC, the Radiation Authorization will be signed by the RSO and Chairperson, RSC, assigned a number, distributed and maintained in file.

2. Amendment of Radiation Authorization.

a. Prior to deviating from procedures, requirements or changing usage or storage areas, radionuclides and their limits as specified in his approved Radiation Authorization, the Authorized User will first obtain approval for the proposed changes from the RSC by the issuance of an amendment to his authorization.

b. The Authorized User will prepare and complete one copy of the "Request For Authorization to Use Radioactive Material" form, specifying "Amendment", annotate the proposed change(s) in the appropriate section(s) and provide all associated documents, SOPs, records as required.

c. Procedures in paragraphs C1a(5) - d are repeated.

3. Review of Radiation Authorization.

a. Current Radiation Authorizations require biennial review by the RSC and at other times as requested by the RSO. Authorized Users will prepare and complete one copy of the "Request for Authorization to Use Radioactive Material" form, specifying "Review", with information contained in his initial request and any approved amendments. All documents, records, SOPs, etc.,from his initial request and from any subsequent amendments will accompany the authorization request forms.

b. Procedures in paragraphs C1a(5) - d are repeated.

D. RADIATION SAFETY TRAINING.

1. Prior to working with radioactive materials or equipment that produces ionizing radiation, individuals will receive radiation safety training commensurate with their duties as required in 10 CFR 19.12 by the RSO or other training sources approved by the RSC.

2. Female radiation workers will receive a current copy of, and be instructed to read, USNRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" with Appendices A and B, be informed of their rights about declaring a pregnancy and be instructed to contact the RSO when a pregnancy is declared.

3. Ancillary personnel who may frequent or work in an area where sources of ionizing radiation are used or stored will receive radiation safety training commensurate with their duties.

4. Radiation workers will receive training in the safe use and handling of radioactive materials and such specialized instruction as required by the Authorized User under whose Radiation Authorization they work. Workers will also adhere to the minimum rules of laboratory safety (paragraph E1).

5. All radiation workers will receive annual radiation safety training to be performed by the RSO or other training sources approved by the RSC.

6. Training records will be maintained.

E. RADIATION CONTROL MEASURES.

1. MINIMUM RULES OF LABORATORY SAFETY FOR RADIATION WORKERS.

a. All radiation workers are adequately trained in the hazards, safety precautions and proper use of radioactive materials.

b. Do not eat, chew, drink, use tobacco products (smoke, snuff, chewing tobacco), or apply cosmetics in any area where radioactive materials are stored or in use. Food and drink are not permitted in any area or room, including refrigerators, where radioactive materials are stored or in use.

c. Do not use laboratory glassware or equipment for the preparation or consumption of food or drink. Eliminate all sharp objects, broken glassware, etc., from usage areas and keep areas free from unnecessary materials and equipment.

d. Wear appropriate disposable gloves to prevent hand contamination when handling radioactive materials. Additional protective attire such as lab coats or aprons, face shields or caps may be warranted, depending on the level of activity, hazard of the radionuclide and the type of work planned. Do not handle the telephone, cabinet or drawer handles, door knobs and non-radioactive items with contaminated hands or gloves.

e. Wear your dosimeter (if issued) as required and store it in the approved location when work is completed.

f. Never pipette solutions by mouth.

g. Control and secure all radioactive materials as required, including items, equipment, etc. that are labeled as radioactive.

h. Be aware of external and container surface exposure rates and use remote handling devices when appropriate.

i. Visually inspect the source container for damage or leakage prior to use. Use secondary spill containment whenever possible, i.e., work in a tray with absorbent paper, to limit the spread of contamination. Store the source in a secondary container in case of leakage and transport the source in an unbreakable container (plastic bag) in case of droppage.

j. Use shielding when possible and if appropriate. Pipette from shielded containers and place the containers behind or into shields when not in use. Transport sources in shielding containers.

k. Be aware of the chemical properties of the radionuclide you are working with to avoid uncontrolled releases of activity. Tritium, radioiodines, polonium, ruthenium, plutonium and many others form chemically mobile (volatile) compounds. Others such as Ra-226 give rise to volatile daughter products. Volatile materials will be vented and used in a fume hood.

l. Label all containers (vials, test tubes, flasks, beakers, etc.) of radioactive materials as required. Mark all radiologically contaminated or potentially contaminated containers and equipment clearly with radioactive marking tape.

m. Segregate all radioactive waste from non-radioactive waste. Segregate liquid from solid radioactive waste. Segregate mixed radioactive waste containing hazardous materials from radioactive waste. Dispose of radioactive waste in appropriately labeled receptacles. Obtain approval from the RSO prior to the disposal of any radioactive waste and maintain records for all disposals.

n. Prior to the removal or disposal of empty uncontaminated containers or items to unrestricted areas (normal trash), remove, deface the radioactive label, radiation symbol and/or the words "radioactive materials" or otherwise indicate that the item no longer contains radioactive materials.

o. After the completion of work, change absorbent paper, decontaminate areas, clean up equipment, etc., to avoid any build up of contamination. Wash hands with mild soap and water immediately following work completion. Monitor hands, clothing and work areas for contamination with an appropriate, calibrated survey instrument. Lab coats worn while using radioactive material should not be worn in non-usage areas as contamination on the coat may be spread, absorbed, or ingested if care is not taken.

p. Report all known or suspected exposures, inhalations, contamination, spills, ingestions, absorptions, injections, injuries and missing or lost radiation sources

immediately to the RSO and your supervisor. If a wound, cut, etc., occurs while handling radioactive materials, immediately wash or flush the injured area with running water.

q. Reduce your exposure to radiation by:

(1) Time - work efficiently and expediently;

(2) Distance - Use handling tools (tongs, forceps, etc.);

(3) Shielding - Keep the vial in the container provided and place radioactive materials behind shielding. Use plastic, not lead, to shield beta emitters; and

(4) Practice contamination control procedures.

2. STORAGE AND CONTROL OF RADIOACTIVE MATERIAL.

a. Security of stored material. Personnel will secure from unauthorized removal or access radioactive materials that are stored in controlled or unrestricted areas.

b. Control of material not in storage. Personnel will control and maintain constant surveillance of radioactive material that is in a controlled or unrestricted area and that is not secured.

c. Any radioactive material that is lost, stolen or missing will be immediately reported to the RSO, who will determine by 10 CFR 20.2201 if the NRC requires notification.

3. POSTING REQUIREMENTS.

a. Areas, accessible to individuals, where radioactive materials are used, handled or stored are controlled, restricted areas and shall be posted to warn personnel of the presence of radiation and radioactive materials and the associated potential hazard(s). Areas are appropriately posted with a caution sign(s) having the radiation symbol as:

(1) "Caution - Radioactive Materials" when the amount of radioactive material in the room or area that is in use or in storage exceeds 10 times the quantity of such material specified in Appendix C to 10 CFR 20.1001 - 20.2401;

(2) "Caution - Radiation Area" when radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) or equal to, but not more than, 0.100 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates;

(3) "Caution (or Danger) - High Radiation Area" when radiation levels could result in an individual receiving a dose equivalent in excess of 0.100 rem (1 mSv) in 1 hour at 30 centimeters or equal to, but not more than, an absorbed dose of 500 rads (5 grays) in 1 hour at 1 meter from the radiation source or from any surface that the radiation penetrates;

(4) "Grave Danger, Very High Radiation Area" when radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from the radiation source or from any surface that the radiation penetrates;

(5) "Caution (or Danger) - Airborne Radioactivity Area" when radioactive material concentrations exceed 10% of any derived air concentration (DAC) value specified in Appendix B to 10 CFR 20.1001 - 20.2401;

(6) "Contaminated Area" when excessive radioactive contamination levels warrant decontamination (see paragraph E7b(2));

(7) "Caution - Radioactive Waste" for receptacles for the accumulation or storage of radioactive waste;

(8) "Caution - Radioactive Material Disposal Sink" for specifically designated sinks, approved by the RSO, through which soluble radioactive material is discharged into the sanitary sewerage system for disposal; and

(9) Additional information, as appropriate, may be provided on or near the required sign to alert individuals of potential radiation exposures and to minimize radiation exposure.

b. Posting is not required for:

(1) Rooms or areas containing radioactive materials for periods of less than 8 hours provided that:

(a) The materials are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure to individuals to radiation or radioactive material in excess of the limits specified in paragraph F; and

(b) The room or area is subject to the Authorized User's control; and

(2) Rooms or areas because of the presence of a sealed source provided that the radiation level at 30 centimeters from the surface of the source container or housing does not exceed 0.005 rem (0.05 mSv) per hour.

4. LABELING OF CONTAINERS.

a. Each container shall bear a durable, clearly visible label bearing the radiation symbol and the words "Caution (or Danger), Radioactive Material." The label must provide sufficient information (such as the radionuclide(s) present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment) to permit individuals handling or using the containers or working in the vicinity of the containers to take precautions to avoid or minimize exposures. Additional information, as appropriate, may be provided on or near the required label to alert individuals of potential radiation exposures and to minimize radiation exposure.

b. Prior to the removal or disposal of empty uncontaminated containers or items to unrestricted areas, the radioactive material label, radiation symbol and/or the words "radioactive materials" will be removed, defaced or otherwise indicated that the container or item no longer contains radioactive materials.

c. Labels are not required for containers:

(1) Holding radioactive material in quantities less than the quantities listed in Appendix C to 10 CFR 20.1001 - 20.2401;

(2) Holding radioactive material in concentrations less than those concentrations specified in Table 3 of Appendix B to 10 CFR 20.1001 - 20.2401;

(3) Attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established in paragraph F;

(4) Having excepted quantity or an article of radioactive material as defined and limited by the Department of Transportation (DOT) regulations (Title 49, CFR 173.403(m), (w) and 173.421-424), when the container is in transport and packaged and labeled in accordance with DOT regulations;

(5) That are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record, which must be retained as long as the container is in use for the purpose indicated on the record; and

(6) Installed manufacturing or process equipment.

5. ACCESS TO AREAS.

a. Access to areas or rooms that are posted with the precautionary radiation warning sign(s) is controlled and restricted to protect individuals from exposure to radiation and radioactive materials. Personnel will maintain the security and control of radioactive materials and radiation in these areas.

b. Access to the Calibration Facility in MSL-18, which is a High Radiation Area.

(1) Access, with positive control for each individual entry, to MSL-18 is limited only to those radiation workers who have been approved by the RSC. A notice warning individuals of this requirement is posted to the entrance door to the calibration facility.

(2) Access to the rooftop of MSL is controlled from outside the building by the use of a secured (by lock) grate to the access ladder and from inside the calibration facility by a lock to each of the two rooftop opening steel panel doors.

c. Other controls for the Calibration Facility.

(1) A protective barrier, five feet in height and posted with radiation warning signs, is constructed on the rooftop immediately over the two calibration wells to limit access. The barrier has four red warning lights, posted at the top of each corner, and two bells (continuously ringing) that are activated when the sources are in use (not in their storage positions).

(2) When the sources are in use, red warning lights inside and outside, above the entrance door, the room are activated.

(3) Access to the calibration sources is limited to only those radiation workers who have been trained in the use of these sources and by a key to the calibration well lead shielded cover and a key to the control system for activating the sources from and to their storage positions.

(4) An area exposure rate monitor set at 5 millirem per hour is in the room to alert workers of potential hazards.

6. RADIATION SURVEYS.

a. Radiation monitoring surveys are performed to evaluate known or potential radiological hazards in restricted and unrestricted areas to ensure that radiation exposures to workers and the public are maintained at levels that are as low

as reasonably achievable. These surveys may include the following determinations depending upon the specific needs of the monitoring: radiation levels, surface contamination levels, effluent releases, radioactive waste management, radiation safety and contamination control procedures.

b. The RSO will:

(1) Prior to the use or storage of radioactive materials in an area or room, perform a formal radiation protection survey to evaluate personnel, equipment and safety requirements; and

(2) Perform or ensure the performance of all required surveys for the evaluation of the extent of radiation levels, concentrations or quantities of radioactive material and the potential radiological hazards that could be present.

c. Authorized Users will ensure the performance of:

(1) Daily radiation monitoring surveys for radiation levels in rooms when dispersible forms of radioactive materials equal to or greater than the exempt quantities specified in Schedule B to 10 CFR 30.71 are used;

(2) Quarterly wipe tests for surface contamination in areas, including adjacent unrestricted areas, where dispersible forms of radioactive materials are used or stored. A radiation monitoring survey for accessing radiation levels will be performed in conjunction with the wipe test;

(3) Contamination and/or radiation monitoring surveys on equipment or items used with radioactive materials prior to their removal from the room to an unrestricted area. The RSO will verify the results of these surveys and then approve the removal of the item from the room; and

(4) Radiation monitoring surveys in areas or rooms, including adjacent unrestricted areas, where sealed sources are used or stored.

d. The radiation monitoring and contamination survey records will have, at a minimum, the location, identification of the radiation monitoring or counting instrument used, individual conducting the survey and the date performed, a drawing of the area surveyed with specific points that were surveyed, the measured exposure rates, detected contamination levels, and corrective action taken in the event of excessive contamination or exposure rates.

e. Radiation surveys will be performed with, and their results analyzed by, calibrated equipment. Documented

records will be maintained and provided to the RSO when requested.

7. CONTAMINATION CONTROL AND DECONTAMINATION PROCEDURES.

a. Responsibilities.

(1) The RSO will control radioactive contamination and supervise decontamination procedures.

(2) Each Authorized User will:

(a) Control contamination within his work area and provide the resources for decontamination; and

(b) Promptly report all spills, releases, accidents, incidents, or unusual occurrences so that contamination control procedures may be initiated.

(3) If possible, the individual responsible for the contamination will perform the decontamination.

b. Contamination control.

(1) Methods which should be employed to minimize the spread of radioactive contamination include:

(a) Using personal protective clothing and devices such as rubber or plastic gloves, laboratory coats, shoe covers, head covers, face masks, respirators, etc.;

(b) Using radiation survey instruments capable of monitoring contamination for the particular radionuclide(s) in use;

(c) Using separate, specially marked radioactive waste containers;

(d) Using polyethylene bags to contain waste and to line waste containers;

(e) Limiting traffic and occupancy of work areas where radioactive materials are in use or in storage;

(f) Designing and enforcing work flow and procedures to minimize transfers and manipulations of radioactive material;

(g) Conducting procedures which generate radioactive aerosols, dusts, or gaseous products in fume hoods, glove boxes, or other suitable closed systems;

(h) Designating and posting contaminated and potentially contaminated areas during procedures which are likely to produce contamination;

(i) Covering working surfaces with polyethylene and absorbent disposable material;

(j) Using trays capable of containing a total spill of the liquid radioactive material being used;

(k) Using double containers for vessels of radioactive materials which are easily upset (volumetric flasks);

(l) Avoiding the use of laboratory vacuum systems and lines when using radioactive materials;

(m) Posting cabinets, refrigerators, ovens, etc., where radioactive material is used or stored so that all personnel are advised of its presence. When the item is not used exclusively for radioactive material, the radioactive material should be separated from the other contents and conspicuously posted;

(n) Establishing control points outside contaminated areas where personnel will monitor themselves for contamination with a suitable radiation survey instrument before leaving the area; and

(o) Promptly cleaning up, monitoring and notifying the RSO of all spills of radioactive material.

(2) Contamination in excess of the levels in the following two tables warrant action (decontamination).

Acceptable Levels for Removable Surface Contamination

	Type of Radiation Emitted					
	Alpha		Beta-gamma		Low-risk Beta-gamma	
Type of surface	(μCi/cm^2)	(dpm/100 cm^2)	(μCi/cm^2)	(dpm/100 cm^2)	(μCi/cm^2)	(dpm/100 cm^2)
Unrestricted Areas, including personal clothing worn outside restricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
Restricted areas, including personal clothing worn only in restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,200
Skin	10^{-6}	220	10^{-6}	220	10^{-5}	2,200

Acceptable Surface Contamination Levels for the Uncontrolled Release of Equipment*

Radionuclide	Removable (dpm/100 cm^2)	Total (Fixed + Removable) (dpm/100 cm^2)
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-228, Th-230, Pa-231, Ac-227, I-125, I-129	20	100
Sr-90, I-126, I-131, I-133, Th-natural, Th-232, U-232, Ra-223, Ra-224	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission), except Sr-90 and others specified above	1,000	5,000
Tritium organic compounds, HT, HTO, and metal tritide aerosols	10,000	10,000

* Notes for the above two tables.

1. When surface contamination by both alpha and beta-gamma emitting radionuclides exists, the limits specified for each emitter type should apply independently.

2. These limits apply to contamination deposited on, but not incorporated into the interior of the contaminated item.

3. Beta-gamma emitter values are applicable for all beta-gamma emitters other than those considered low-risk.

4. Low-risk beta-gamma emitters include C-14, H-3, S-35 and others whose beta energies are less than 0.2 MeV maximum and gamma emission is less than 0.1 R/hr at 1 meter per curie.

5. The amount of removable radioactive material per 100 cm^2 of surface area, or 300 cm^2 for larger surfaces, should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive materials on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface area should be swiped and the activity per unit area should be based on the actual surface

area. Measurements of average contaminant should not be averaged over more than 1 square meter.

6. Except for transuranics, Ra-226, Ra-228, Ac-227, Th-228, Th-230, Pa-231 and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

c. Decontamination procedures.

(1) General. Decontamination methods are many and varied.

(a) A decontamination kit with all required supplies should be immediately available to expedite decontamination procedures and therefore reduce potential exposure to radiation and radioactive materials.

(b) Cleaning agents normally used in the laboratory should be adequate, however Radiac or Decon wash should be used to expedite decontamination efforts.

(c) An appropriate, calibrated radiation survey instrument or wipe tests should be used to monitor the effectiveness of the decontamination procedure.

(d) Continued decontamination efforts should be employed until acceptable levels have been obtained or otherwise approved by the RSO.

(e) Some degree of fixed contamination may occur. The RSO will provide further, specific guidance and approve the release of contaminated personnel and items to unrestricted areas.

(f) Contaminated cleaning equipment, items, articles, etc. will be collected as radioactive waste and disposed as directed by the RSO.

(2) Decontamination of individuals.

(a) Remove contaminated clothing at the earliest opportunity; collect, store and dispose as directed by the RSO.

(b) Promptly perform decontamination of the skin/hands by applying water, a mild soap or detergent (no solvents), and working up a good lather with plenty of water. Rinse and dry thoroughly. Monitor for effectiveness.

(c) If contamination is still excessive, repeat the procedure 3 to 4 times, using a soft bristle brush and taking care not to abrade or scratch the skin. Clipping of the fingernails or cuticles may remove a significant amount of contamination remaining on the hands after washing. Monitor for effectiveness.

(d) If contamination is still excessive, use a more abrasive soap, taking care to prevent the absorption of the contamination through the skin. If excessive contamination still exists, the RSO will provide specific guidance for preventing cross-contamination.

(e) Apply lanolin/cream to prevent chapping.

(f) Wounds suspected of contamination should be irrigated profusely with warm water and cleaned with a swab; procedures should be performed under the supervision of medical personnel.

(3) Decontamination of surface areas, equipment.

(a) Personnel will wear protective gloves and, as required, clothing, shoe covers, etc. to prevent cross-contamination.

(b) Start decontamination procedures as soon as possible.

(c) Start at the periphery of the contaminated area and work inward, reducing the contaminated area systematically.

(d) Monitor for effectiveness and continue decontamination procedures until acceptable contamination levels have been obtained or otherwise determined by the RSO.

(e) Collect all contaminated materials used as radioactive waste and dispose as directed by the RSO.

8. Respiratory protection. Due to limited quantities of radioactive materials used and handled by workers and the radiation control and safety measures employed to prevent the intake of radioactive materials, the use of respiratory protection equipment by personnel is not required. When required, respiratory protection equipment and procedures will be in accordance with 10 CFR 20.1703.

F. RADIATION DOSE LIMITS.

1. Occupational dose limits for adults. Occupational dose shall be controlled, except for planned special exposures under

10 CFR 20.1206, for the following dose limits.

a. An annual limit, which is the more limiting of:

(1) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(2) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

b. The annual limits to the lens of the eye, to the skin, and to the extremities, which are:

(1) An eye dose equivalent of 15 rems (0.15 Sv); and

(2) A shallow-dose equivalent of 50 rems (0.5 Sv) to the skin or to any extremity.

c. In addition to the annual dose limits, the soluble uranium intake by an individual shall be limited to 10 milligrams in a week in consideration of chemical toxicity (refer to footnote 3 to Appendix B to 10 CFR 20.1001 - 20.2401).

2. Occupational dose limits for minors. The annual occupational dose limits for minors are 10 percent of the annual dose limits for adult workers.

3. Dose to the embryo/fetus.

a. Due to the occupational exposure of a declared pregnant worker, the dose to the embryo/fetus during the entire pregnancy shall not exceed 0.500 rem (5 mSv).

b. The dose to the embryo/fetus shall be the sum of:

(1) The deep-dose equivalent to the declared pregnant worker; and

(2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant worker.

c. If the dose to the embryo/fetus is found to have exceeded 0.500 rem (5 mSv) or is within 0.050 rem (0.5 mSv) of this dose by the time the worker declares the pregnancy, the additional dose to the embryo/fetus shall not exceed 0.050 rem (0.5 mSv) for the remainder of the pregnancy.

4. Individual members of the public.

a. For the protection of individual members of the public, licensed activities and operations shall be conducted to ensure that:

(1) The total effective dose equivalent does not exceed 0.100 rem (1 mSv) in a year, exclusive of the dose contribution from the disposal of radioactive material into sanitary sewerage in accordance with 10 CFR 20.2003; and

(2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour.

b. These dose limits also apply if members of the public (visitors) are permitted access to controlled areas by workers.

Summary Table for Dose Limits

Type of Exposure	Annual Limit
Radiation worker:	
Whole Body (internal + external)	5 rem
Lens of the eye	15 rem
Extremity (hands and arms below the elbow; feet and legs below the knees)	50 rem
Any organ or tissue (other than the lens of the eye) and skin	50 rem
Minors: 10% of the above limits	
Embryo/fetus of Declared Pregnant Worker (internal + external)	0.5 rem in 9 months
Visitors, public and minors:	
Whole Body (internal + external)	0.1 rem

G. PERSONNEL MONITORING.

1. General.

a. Personnel monitoring is used to quantitatively estimate the magnitude of individual exposures to sources of ionizing radiation and detect hazardous conditions relating to

ionizing radiation exposure not detected during radiation protection surveys.

b. The dose that an individual may be allowed to receive in the current year will be reduced by the amount of occupational dose received while employed by a non-EPA facility.

c. When required, the summation of external and internal doses will be in accordance with 10 CFR 20.1202.

d. Doses received in excess of the annual limits, including doses received during accidents, emergencies and planned special exposures, will be subtracted from the limits for planned special exposures that the individual may receive during the current year and the individual's lifetime.

e. When required, planned special exposures for personnel will be conducted, performed, recorded and reported as required by 10 CFR 20.1206, 20.2104(b), 20.2105 and 20.2204.

2. Requirements for external monitoring. Monitoring the occupational exposure to radiation from sources external to the body and the employment and use of individual monitoring devices is required for:

a. Adults likely to receive, in 1 year, a dose in excess of 10 percent of the limits specified in paragraphs F1a and b;

b. Minors and declared pregnant workers likely to receive, in 1 year, a dose in excess of 10 percent of the limits specified in paragraphs F2 and 3;

c. Individuals entering a high radiation area; and

d. Individuals selected by the Laboratory Director or RSO.

3. Requirements for internal monitoring. Monitoring the occupational intake of radioactive materials and the assessment of the committed effective dose equivalent is required for:

a. Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable annual limit on intake(s), or ALI(s), in Table 1, Columns 1 and 2, of Appendix B to 10 CFR 20.1001 - 20.2401; and

b. Minors and declared pregnant workers likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.050 rem (0.5 mSv).

4. Personnel Dosimetry Accreditation. All personnel dosimeters, excluding direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities, that require processing to determine the radiation dose shall be processed and evaluated by a processor holding a current personnel dosimetry accreditation and approved in this accreditation process for the type of radiation or radiations that closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

5. Devices and Methods for Personnel Monitoring.

a. External Monitoring.

(1) The primary device for external personnel monitoring is the thermoluminescent dosimeter (TLD), which is sensitive to various types of radiations. The whole body TLD is used by personnel to measure the exposure received to the whole body. Other dosimetry devices approved by the RSO may be used to supplement the whole body TLD.

(2) When determining the external dose from airborne radioactive material, the contribution to the deep-dose equivalent, eye dose equivalent and shallow-dose equivalent from the external exposure to the radioactive cloud will be included.

(3) The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure. The deep-dose equivalent, eye dose equivalent and shallow-dose equivalent may be assessed from surveys or other radiation measurements if the individual monitoring device was not in the region of highest potential exposure or the results of individual monitoring are unavailable.

b. Internal Monitoring.

(1) For purposes of determining internal exposure, suitable and timely measurements will be taken of:

(a) Concentrations of radioactive materials in air in work areas;

(b) Quantities of radionuclides in the body;

(c) Quantities of radionuclides excreted from the body; or

(d) Combinations of these measurements.

(2) Derived air concentration (DAC) and annual limit on intake (ALI) values in Table 1 of Appendix B to 10 CFR

20.1001 - 20.2401 may be used to determine an individual's dose.

6. Administration.

a. After receiving radiation safety training from the RSO, the individual will report to the External Dosimetry Manager and complete an application for a dosimeter and provide previous employment radiation exposure information.

b. Upon issuing the individual a dosimeter, the External Dosimetry Manager will initiate a dosimetry file for the individual and request/obtain previous radiation exposure records which will be included into the individual's dosimetry record and maintained in file.

c. Dosimeters will be worn on a quarterly basis, exchanged by the External Dosimetry Manager, or when deemed otherwise by the RSO.

d. Personnel will adhere to those procedures for the usage and storage of their dosimeters (paragraph H) and will obtain approval from the RSO and a control dosimeter from the External Dosimetry Manager prior to taking their dosimeter to a place of duty not normally encountered (out-of-state, foreign country, etc.).

e. When terminating employment, transferring or leaving EPA, EMSL-LV, personnel will out-process the offices of the RSO and Internal/External Dosimetry Manager.

f. Personnel monitoring for certain individuals may be discontinued at the discretion of the RSO.

g. Prior to entering an existing High Radiation Area, individuals will obtain and wear a pocket dosimeter and annotate the required information into the logbook prior to entering and after leaving the area. The RSO will be immediately notified of any abnormal pocket dosimeter readings.

h. Each location for storing dosimeters when not being worn by individuals will be approved by the RSO. A Control dosimeter will be placed at each storage location to measure background radiation.

7. Reports and records. The Internal/External Dosimetry Manager will maintain and provide reports and records as required in paragraph B4a.

8. Notifications.

a. The Internal/External Dosimetry Manager will immediately notify the RSO of those radiation exposures/doses

specified in paragraph B4b.

b. The RSO will perform investigations and inform the RSC of those exposures specified in paragraph I and notify the NRC of reportable exposures.

H. PROCEDURES FOR THE USAGE AND STORAGE OF PERSONNEL DOSIMETERS (TLD's).

1. Dosimeters will not be used for any purpose other than personnel monitoring without the approval of the RSO. Dosimeters are used to measure the radiation dose received by personnel who are occupationally exposed to radiation as radiation workers.

2. Dosimeters will be worn only by the individual to whom they are issued and are to be worn when working with sources of radiation. Other dosimeters to be worn will be approved and worn as mandated by the RSO.

3. The whole body dosimeter is to be worn on the front, upper torso of the body between the neck and waist, with the thin plastic window on the face of the dosimeter facing away from the body.

4. When not being worn, the dosimeter will be stored only in the approved storage location. Dosimeters are not to be taken home or stored in desks, lockers, radiation usage/storage areas, on lab coats, etc.

5. Dosimeters will not be intentionally exposed, tampered with, or damaged in any way and protected from heat, thermal shock and the sun.

6. Dosimeters will not be worn during medical/dental x-ray diagnosis or therapy exposures involving radiation. Notify the RSO if you are scheduled to receive or have received a radioisotope treatment, i.e., the injection or administration of radioactive materials into your body. You will not wear your dosimeter during or after the procedure until approval has been obtained from the RSO.

7. Immediately notify the RSO when a dosimeter is lost, misplaced, missing, accidently exposed/contaminated or damaged.

8. EMSL-LV's dosimeters will not be worn by workers when performing non-EPA duties at other facilities while being occupationally exposed to radiation. Personnel will provide their non-EPA exposure records to the External Dosimetry Manager for inclusion into their dosimetry record and file.

9. If you are required to wear your dosimeter at a duty location not normally encountered (out-of-state, foreign country,

etc.), obtain instructions and approval from the RSO and a Control dosimeter from the External Dosimetry Manager prior to leaving for that duty location.

I. ALARA PROGRAM.

1. Purpose. To provide guidance for maintaining radiation exposures (individual and collective) at a level that is As Low As Reasonably Achievable (ALARA).

2. Scope. To prescribe the principles and practices for maintaining radiation exposures ALARA and designate responsibilities for the administration and operation of the program.

3. Definition. ALARA means "As Low As Reasonably Achievable" taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety.

4. Responsibilities.

a. The EMSL-LV Laboratory Director is:

(1) Committed to the program described herein for keeping radiation exposures (individual and collective) ALARA.

(2) To ensure that a formal review of the radiation safety program is conducted annually.

(3) To ensure that modifications to equipment, facilities, and operating and maintenance procedures for reducing exposure levels will be implemented unless the cost is considered unjustified.

b. Radiation Safety Committee (RSC).

(1) The RSC will thoroughly review the qualifications of each applicant with respect to the requested types and quantities of materials and their usages to ensure that the applicant will be able to take appropriate measures to maintain exposures ALARA.

(a) When considering a new use of radioactive material, the RSC will review the applicant's efforts to maintain exposures ALARA. The applicant will have systematized procedures to ensure exposures are ALARA and will incorporate the use of special equipment in his proposed use.

(b) The RSC will ensure that the applicant justifies his procedures and that doses (individual and collective) to workers and the public will be ALARA.

(2) Delegation of Authority. The judicious delegation of RSC authority is essential to the enforcement of an effective ALARA program.

(a) The RSC will delegate authority to the RSO to implement and enforce the ALARA concept.

(b) The RSC will support the RSO in those instances where it is necessary for the RSO to assert his authority. When the RSO has been overruled, the RSC will record the basis for its actions in the minutes for the RSC meeting.

(3) Review of ALARA Program.

(a) The RSC will encourage all users to review concurrent procedures and develop new procedures, as appropriate, to implement the ALARA concept.

(b) The RSC will perform a quarterly review of occupational radiation exposures with particular attention to instances when the Investigational Levels in paragraph 5a are exceeded. The principle purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when Investigational Levels are exceeded.

(c) The RSC will evaluate the laboratory's overall efforts for maintaining exposures ALARA on an annual basis. This review will include the efforts of the RSO, Authorized Users and workers as well as those of management.

c. Radiation Safety Officer (RSO).

(1) Reviews.

(a) Annual Review of the Radiation Safety Program. The RSO will perform an annual review of the Radiation Safety Program for adherence to ALARA concepts. Reviews of specific procedures may be conducted on a more frequent basis.

(b) Quarterly Review of Occupational Exposures. The RSO will review at least quarterly the external radiation exposures of radiation workers to determine that their exposures are ALARA in accordance with the provisions of this program.

(c) Quarterly Review of Records of Radiation Levels. The RSO will review at least quarterly the records of radiation levels in unrestricted and restricted areas and the releases of effluents to unrestricted areas to determine that the levels are ALARA.

(d) Other Reviews. The RSO will review, as required, the internal radiation exposures of radiation workers to determine that their exposures are ALARA in accordance with the provisions of this program.

(2) Education Responsibilities for an ALARA Program.

(a) The RSO will schedule briefings and educational sessions to inform workers of ALARA program efforts.

(b) The RSO will ensure that Authorized Users, workers, and ancillary personnel who may be exposed to radiation are instructed in the ALARA philosophy and informed that the Laboratory Director, RSC and the RSO are committed to the ALARA concept.

(3) Cooperative Efforts for the Development of ALARA Procedures. Radiation workers will be provided opportunities and encouraged to participate in the formulation of the procedures that they will be required to follow.

(a) The RSO will maintain close contact with Authorized Users and workers in order to develop ALARA procedures for working with radioactive materials and other sources of ionizing radiation.

(b) The RSO will receive and evaluate the suggestions of individual workers for improving radiation safety practices and encourage the use of those procedures.

(4) Reviewing and Reporting Instances of Deviation from Good ALARA Practices.

(a) The RSO will investigate all known or suspected deviations from good ALARA practices and, if possible, determine the cause. When the cause is known, the RSO will require changes in the program to maintain exposures ALARA.

(b) The RSO will report all significant deviations from good ALARA practices to the RSC for review.

d. Authorized Users.

(1) New Procedures Involving Potential Radiation Exposures.

(a) The Authorized User will consult with and receive the approval of the RSO during the planning stage before performing a new procedure utilizing radioactive materials.

(b) The Authorized User will evaluate all aspects of the procedure to ensure that exposures will be kept ALARA. This may be enhanced through the application of trial runs.

(c) The Authorized User will amend (by the submission of documentation to the RSC for the new procedure) his Radiation Authorization before performing the new procedure.

(2) Responsibility of the Authorized User to those who he supervises and/or use radiation sources under his authorization.

(a) The Authorized User will explain the ALARA concept and his commitment to maintain exposures ALARA to these personnel.

(b) The Authorized User will ensure that workers who are subject to occupational radiation exposure are trained and educated in good radiation safety practices and in maintaining exposures ALARA.

e. Individuals Who Receive Occupational Radiation Exposure and/or Work with Sources of Ionizing Radiation.

(1) The worker will be instructed in the ALARA concept and its relationship to his working procedures and work conditions.

(2) The worker will know what resources are available if he feels that ALARA is not being promoted on the job.

5. Establishment of Investigational Levels in Order to Monitor Individual Occupational Radiation Exposures.

a. The following Investigational Levels are established for occupational radiation exposure to individuals which, when exceeded, will initiate an investigation by the RSO.

(1) Investigation Level I.

(a) External exposure. Quarterly exposures for adults are 100 mrem to the whole body, 1.25 rem for shallow-dose and 375 mrem to the lens of the eye. Quarterly exposures for minors and declared pregnant workers are 10% of the adult exposures, excluding the quarterly whole body exposure of 50 mrem for minors and the monthly whole body exposure of 25 mrem for declared pregnant workers.

(b) Internal exposure. Those levels specified in paragraphs G3a and b during any calendar year.

(2) Investigational Level II. These levels are established at three times the levels of Investigational Level I.

b. The following actions are required for the specified Investigational Levels.

(1) Personnel exposures less than Investigational Level I. No action is required unless determined by the RSO.

(2) Personnel exposures equal to or greater than Investigational Level I, but less than Investigational Level II. The RSO will investigate these exposures and submit to the RSC his report. The RSC is not required to take action for these exposures unless deemed otherwise. The RSC will, however, consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the RSC minutes.

(3) Personnel exposures equal to or greater than Investigational Level II. The RSO will investigate the cause(s) for these exposures and take action, if required. The RSO's investigative report, actions taken and a copy of the individual's radiation exposure record will be presented to the RSC for review. The details of these reports and the RSC's recommendations and actions, if any, will be recorded in the RSC minutes.

(4) Re-establishment of an individual occupational worker's Investigational Level II above that listed in paragraph 5a(2).

(a) In cases where a worker's or a group of workers' exposures need to exceed Investigational Level II, a new, higher Investigational Level II may be established on the basis that it is consistent with good ALARA practices for the individual or group. Justification for a new Investigational Level II will be documented.

(b) The RSC will review the justification for and will approve all revisions of Investigational Levels II. In such cases, when the exposure equals or exceeds any newly established Investigational Level II, those actions specified in paragraph I5b(3) above will be followed.

J. PRENATAL RADIATION SURVEILLANCE PROGRAM.

1. A "declared pregnant woman" is a radiation worker who has voluntarily informed, in writing, her supervisor of her pregnancy and the estimated date of conception.

2. At the time of declaring her pregnancy, the worker will consult the RSO, who will:

a. Ensure that the worker has read her copy of USNRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" with Appendices A and B, that was previously provided and answer any questions that she might have; and

b. Review, with the worker, her radiation exposure history (if applicable), advise her of potential risks due to occupational radiation exposure, counsel her in precautionary procedures to minimize the exposure to her and the fetus, and inform her that if she continues her normal duties in her current working environment, the radiation dose equivalent to the fetus (dependant upon the time of declaration of the pregnancy) will not exceed 500 millirem for the entire gestation period.

3. The worker will be requested to acknowledge by a signed statement the above information in paragraph J2 and will be provided a copy of that acknowledgement.

4. The worker and her supervisor will make every reasonable effort to minimize additional exposure to the worker. The worker may consult her supervisor for advice if she desires not to perform duties involving exposure to radiation.

K. MEDICAL SURVEILLANCE PROGRAM.

The past and present radiation exposures received by EMSL-LV personnel and the types and quantities of radionuclides used and handled by personnel negates the need for a medical surveillance program for radiation workers. Clinical effects can not be observed nor expected for radiation exposures received. Under special circumstances, the RSO may require the medical evaluation of a worker due to a known/suspected overexposure to radiation.

L. PROCUREMENT, RECEIPT, TRANSFER AND SHIPMENT OF RADIOACTIVE MATERIALS AND EQUIPMENT THAT PRODUCES IONIZING RADIATION. The RSO will approve the procurement, receipt, transfer (including in/out of EMSL-LV and between Authorized Users) and shipment of radioactive materials and equipment that produces ionizing radiation.

1. Procurement. In this context, "procurement" means the purchase of any radioactive material or equipment that produces ionizing radiation, regardless of radioactivity, through EMSL's, or a non-EMSL, purchasing agent and/or the receipt by transfer from a non-EMSL activity/supplier of a gift, donated or loaned, or demonstration sample, or any other receipt regardless of any monetary transaction involved.

a. Only an Authorized User can request and procure those radionuclides currently specified in his Radiation Authorization. The Authorized User will ensure that the material being requested is authorized and the requested quantities, in

addition to the amounts he has on-hand (including waste), will not cause him to exceed the limits specified in his Radiation Authorization.

b. All procurement requests will be approved by the RSO by signature. EMSL-LV procurement personnel will not honor an unauthorized purchase request for radioactive materials.

c. Shipments of radioactive materials will be addressed to EPA, EMSL-LV, Chemistry Lab Receiving, 944 E. Harmon Avenue, Las Vegas, NV 89119-6721. Electronic and other larger items of equipment will be addressed to EPA, 3876 West Ponderosa, Building #5, Las Vegas, NV 89118. The RSO is to be consulted concerning special shipments.

d. Procedures. The Authorized User will:

(1) Contact the RSO to obtain an RS number for the radionuclide and its shipment and provide the requested information;

(2) Prepare and ensure the procurement request contains, at a minimum, the Authorized User's name and signature, EMSL-LV's delivery address, supplier's name and address, the phrase "RADIOACTIVE MATERIALS," RS#, radionuclide and its activity; and

(3) Forward the purchase request to the RSO, who will forward the request, once approved, to purchasing personnel.

e. Any deviation from those procedures in paragraph L1d will be approved by the RSO prior to the deviation.

2. Receipt of packages.

a. All packages, whether or not they contain radioactive materials, are delivered to EMSL-LV only during normal working hours; packages are not delivered or received after duty hours.

b. Monitoring the external surfaces of packages is required for the following types of packages containing radioactive materials and will be performed as soon as practicable, but not later than 3 hours after the package is received. Packages not having the following requirements do not require monitoring unless deemed otherwise by the RSO.

(1) Packages known to contain radioactive material that have evidence or degradation of package integrity (crushed, wet or damaged) will be monitored for radioactive contamination and radiation levels.

(2) Packages containing quantities of radioactive materials that are in excess of the Type A quantity, as defined in 10 CFR 71.4 and Appendix A to 10 CFR Part 71, will be monitored for radiation levels.

(3) Packages labeled with a Radioactive White I, Yellow II, or Yellow III, unless the package contains only radioactive material in the form of a gas or in special form (as defined in 10 CFR 71.4), will be monitored for radioactive contamination.

c. The Authorized User, his authorized radiation workers and RSO are authorized to receive and monitor packages.

d. Procedures for receiving packages.

(1) Don gloves if contamination is suspected and visually inspect the package. Verify that the designated receiver of the package as specified on the shipping label is correct.

(2) Perform the required monitoring if the package is labeled as Radioactive White I, Yellow II or III, contains quantities of radioactive materials in excess of the Type A quantity or is crushed, damaged or wet.

(3) Monitoring the external surfaces of the package will be performed by:

(a) The use of an appropriate, calibrated radiation survey instrument to determine the radiation levels; and/or

(b) Wiping an area of 300 cm^2 on the surface with an absorbent material, using moderate pressure, and measuring the activity on the wiping material to determine the non-fixed (removable) radioactive contamination. The results of the wipe can be obtained either by counting the wipe in a calibrated counting instrument or by using, in a low-background area, an appropriate, calibrated radiation survey instrument.

(4) Immediately notify the RSO and discontinue procedures if the monitoring results indicate that:

(a) Radiation levels at any one point on the external surface of the package exceed 200 millirem per hour or the Transport Index, annotated on the Radioactive White I, Yellow II or III label (if present), exceeds 10; or

(b) Removable contamination activity (averaged over the surface wiped) on the external surface of the

package exceeds:

- 22.0 dpm/cm^2 or 10^{-5} μCi/cm^2 for beta-gamma emitting radionuclides, all radionuclides with half-lives less than 10 days, U-natural, U-235, U-238, Th-natural, Th-232, Th-228 and Th-230 when contained in ores or physical concentrates; or

- 2.2 dpm/cm^2 or 10^{-6} μCi/cm^2 for all other alpha emitting radionuclides.

(5) Open the package and remove the packaging material and the source. Verify the contents with the shipping documents.

(6) Perform monitoring of the packaging material and source if contamination is suspected and decontaminate as required Items contaminated will be disposed as radioactive waste.

(7) Prior to the disposal of uncontaminated packages, packaging material, etc. into the normal trash, remove or deface the radioactive label, radiation symbol and the words "radioactive materials" or otherwise indicate that the item no longer contains radioactive materials.

(8) Check gloves (and hands) for contamination and dispose accordingly.

(9) Immediately notify the RSO of all discrepancies.

(10) Document the receipt of the package on the radioisotope receipt report and forward the report to the RSO. Initiate an accountability record for the radionuclide(s).

3. Transfer of radioactive materials and equipment that produces ionizing radiation.

a. All incoming, outgoing and within EMSL-LV transfers will be approved by the RSO prior to the transfer and will be accomplished only by an Authorized User and/or the RSO.

b. All incoming transfers, including equipment containing radiation sources or producing ionizing radiation, will be treated as a "procurement" as the RSO will assign an RS# for the radionuclide and its transfer.

c. Outbound transfers will comply with applicable parts in 10 CFR and 49 CFR (DOT) requirements for the shipping, labeling, monitoring and transportation of the material. Such

transfers will only be performed to persons or activities licensed to receive and possess the radioactive material; verification of such will be in accordance with 10 CFR 30.41.

d. The RSO will be notified and approval obtained prior to the outbound transfer from EMSL-LV of any radioactive material, source or equipment that produces ionizing radiation to a vendor for repair, replacement or disposal.

4. Shipment of radioactive materials.

a. All shipments and the transportation of shipments of radioactive material will be approved by the RSO.

b. The requirements, and exemptions from requirements, for packaging and description, marking and labeling, placarding of vehicles, monitoring for radiation levels and radioactive contamination, modes of transportation, shipping papers, accident reporting and record keeping will be in accordance with applicable parts in 10 CFR and 49 CFR (DOT regulations), Parts 171 through 180.

M. ACCOUNTABILITY AND INVENTORY OF RADIOACTIVE MATERIAL AND EQUIPMENT THAT PRODUCES IONIZING RADIATION.

1. Each Authorized User will:

a. Maintain an accurate inventory of all radioactive material, including that amount in waste that he has generated, in his possession and ensure that his quantities on-hand do not exceed the possession limits specified in his Radiation Authorization. Quantities in excess of possession limits will be provided to the RSO for storage;

b. Maintain an accountability record of all radioactive material that is received, used, and lost through radioactive decay, disposal or shipment; and

c. Perform a physical and semiannual inventory of all his radioactive materials, including sealed sources, equipment that produces ionizing radiation, and provide the inventory to the RSO.

2. The inventory will specify each radionuclide, its RS# and date of receipt (if known), current (decayed) activity, location, amounts in storage as waste, and for the semiannual period, the amounts disposed or shipped, and the date that the inventory was performed. The inventory of sealed sources and equipment that produces ionizing radiation will include the manufacturer, model and serial number of the source and equipment (if known).

3. The RSO will ensure that the total inventory of any radionuclide on-hand does not exceed the possession limits specified in EMSL-LV's NRC license.

N. WASTE DISPOSAL.

1. Responsibilities.

a. The RSO is responsible for the control, management and disposal of all radioactive waste.

b. The SHEM is responsible for the management and disposal of mixed radioactive materials containing hazardous materials.

c. The Authorized User will:

(1) Maintain an inventory of the radioactive waste in his possession and documented records for all disposals of radioactive waste, including liquid scintillation vials;

(2) Secure, control, segregate, store, dispose and/or package his waste as required by this manual, the RSO and SHEM;

(3) Provide appropriate containers for waste and ensure that all containers are identified and labeled as required; and

(4) Obtain approval from the RSO prior to any local disposal of waste into the sewerage system or relinquishing custody of mixed waste to the SHEM for disposal.

2. Radioactive materials containing hazardous materials, as defined in 40 CFR Part 261, will be disposed by the SHEM and RSO. The treatment or disposal by incineration of waste is not authorized. The following disposals of radioactive waste containing non-hazardous materials are authorized. Other methods for disposal will be approved by the RSC.

a. Decay in storage. Short-lived radionuclides are held for ten half-lives and, after monitoring has been performed to verify that background radiation levels are not exceeded and the removal or defacing of all radiation labels, symbols, or the words "radioactive materials," are disposed as non-radioactive waste.

b. The release of soluble and readily dispersible biological materials into the sanitary sewerage system. The quantities released will not exceed the average monthly concentrations specified in Table 3, Appendix B, 10 CFR 20.1001 - 20.2401. The total quantity released in a year will not exceed

5 curies (185 GBq) of Hydrogen-3, 1 curie (37 GBq) of Carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

c. The disposal of specific wastes as if the waste is not radioactive. Authorized for disposal is 0.05 microcuries (1.85 kBq), or less, of Hydrogen-3 or Carbon-14 per gram of medium used for liquid scintillation counting or animal tissue, averaged over the weight of the entire animal.

d. Radioactive solutions may be precipitated or evaporated to dryness and then treated as solid waste.

e. The transfer of waste to a licensed facility authorized to receive, store, transfer and dispose of the waste. The shipment and transportation of radioactive waste will be performed by the RSO in accordance with applicable parts in 10 CFR and DOT regulations, 49 CFR Parts 171 through 180.

3. All radioactive waste will be segregated from non-radioactive waste to ensure that the radioactive waste on-hand at EMSL-LV is kept to a minimum. All containers of radioactive waste will be labeled and identified as required and segregated as follows.

a. Liquid waste will be segregated from solid waste.

(1) Liquid waste retained for disposal should be collected in plastic bottles or sealed, leak-proof cans to reduce possible breakage. Liquid waste which chemically or otherwise reacts with plastic should be placed in glass bottles, which in turn should be placed into a plastic container to prevent spillage in case of droppage.

(2) Solid waste will be placed in plastic bags or a receptacle lined with a plastic bag. When filled and ready for removal, the opening of the bag will be secured with tape.

b. Radioactive waste will be segregated from mixed radioactive waste containing hazardous materials.

c. The longer-lived radionuclides should be segregated from the shorter-lived radionuclides to facilitate decay in storage and local disposal.

4. Records for all disposals will be maintained.

O. LEAK TESTING OF SEALED SOURCES.

1. Sealed sources and detector cells will be tested for leakage and/or contamination at intervals not to exceed 6 months or at other intervals as specified by 10 CFR 32.210.

2. Sealed sources designed to emit alpha particles will be tested for leakage and/or contamination at intervals not to exceed 3 months.

3. In the absence of a certificate from a transferor indicating that a leak test has been performed within 6 months prior to the transfer, a sealed source or detector cell received from another person will not be used until tested.

4. Each EMSL-LV fabricated (electrodeposited or electroplated) sealed source will be inspected and tested for construction defects, leakage and contamination prior to any use. These sources are to be used only in-house and will not be transferred from EMSL-LV.

5. Sealed sources need not be leak tested if:

a. They contain only hydrogen-3 or a radioactive gas;

b. The half-life of the isotope is 30 days or less;

c. They contain not more than 100 microcuries of beta and/or gamma emitting material or not more than 10 microcuries of alpha emitting material; or

d. They are not designed to emit alpha particles, are in storage and are not being used. When removed from storage for use or transfer and have not been tested within the required leak test interval, they will be tested before use or transfer. No sealed source or detector cell will be stored for a period of more than 10 years without being tested for leakage and/or contamination.

6. The leak test will be capable of detecting the presence of 0.005 microcuries of radioactive material on the test sample. The results of all leak tests will be annotated in microcuries.

7. Sealed sources or detector cells will not be opened and sources will not be removed from the source holder.

8. The RSO will:

a. Perform or ensure the performance of leak tests and maintain records as required;

b. Immediately remove a source indicating the presence of 0.005 microcurie or more of removable contamination from use and decontaminate, repair or dispose of the source; and

c. File a written report to the NRC within 5 days after it has been determined that the leak test result of a sealed source is 0.005 microcurie or greater.

P. CALIBRATION OF INSTRUMENTS USED FOR LICENSED ACTIVITIES.

1. General.

a. Calibrations of instruments will be performed by the use of a calibrated radioactive standard that is traceable to National Institute of Standards and Technology (NIST).

b. Calibration procedures will be in accordance with the manufacturer's specifications or procedures approved by the RSO.

c. Documented records for calibrations and other tests will be maintained and available for review by the RSO.

2. Portable radiation survey instruments.

a. Specific calibration procedures vary among instruments because of the characteristics of the instruments, however the following requirements are common for all calibrations:

(1) Calibrations are performed annually and by the use of a calibrated source having ±5 percent accuracy;

(2) Each scale will be calibrated at two points (at least), which are located approximately at 20 percent and 80 percent of full scale, depending upon the full scale;

(3) For logarithmic rate-changing instruments, the calibration will be made near the mid-range of each decade and two points will be calibrated on at least one of the decades; and

(4) The measured exposure rate will differ from the true exposure rate by less than or equal to ± 10 percent at the calibration points. Readings greater than ± 10 percent but less than ± 20 percent are acceptable provided that a calibration chart, graph, or response factor is prepared and used with the instrument to interpret readings to within ± 10 percent for radiation protection purposes.

b. An instrument database will be maintained, specifying the calibration date, calibration due date, status and location of each instrument.

c. Each calibrated instrument will have an affixed label indicating the calibration date, calibration due date and initials of the individual who performed the calibration.

d. Instruments that are not operable or out of calibration will be appropriately tagged and not used.

3. Instruments/counters that evaluate wipe test results.

a. Quality Control checks will be performed on the instrument or counter prior to its usage.

b. The following tests will be performed at least annually and whenever a new detector has been installed:

(1) Chi-square (reproducibility) test;

(2) Counting efficiencies;

(3) High voltage (plateau) determination; and

(4) Minimum detectable activity (MDA).

Q. RADIOACTIVE DETECTORS IN GAS CHROMATOGRAPHY.

1. General.

a. Gas chromatographs with electron capture detectors contain sealed sources such as Nickel-63 or Hydrogen-3.

b. Sealed sources or detector cells will not be opened or sources removed from the source holder by personnel.

c. The maintenance, repair, cleaning, replacement and disposal of foils contained in detector cells will be performed only by the device manufacturer or persons specifically authorized by the NRC, Agreement State, or Licensing State to perform such services.

d. The removal, handling and transfer of the source and its container to a vendor for repair, replacement or disposal will be coordinated with and approved by the RSO.

e. When not physically installed in the unit, sources and their containers will be labeled as required, controlled and secured to prevent unauthorized removal.

f. Detector cells containing a titanium tritide foil or a scandium tritide foil will:

(1) Only be used in conjunction with a properly operating temperature control mechanism which prevents the foil temperature from exceeding that specified by the manufacturer and approved by the NRC; and

(2) Be vented to the outside when in use.

g. Associated hazards are both external and internal exposure, however external hazards are generally non-existent and

therefore personnel are not issued dosimeters. The degree of hazard dependents upon the radionuclide, activity, encapsulation and the operating factors involving the use of the source.

2. Instrument operation.

a. The Authorized User is responsible for the safe and proper operation of the unit and will ensure that his authorized radiation workers have been adequately trained in the usage and safety procedures for the instrument.

b. All safety and control devices will be checked for complete operability at least annually and after a source has been replaced.

c. The unit will not be operated at temperatures greater than the manufacturer's specifications.

d. Whenever there is suspect that the high-temperature-limit devices have malfunctioned or otherwise permitted the detectors to be heated above their maximum operating temperature, the unit will be turned off and the RSO notified immediately.

R. RADIOLOGICAL EMERGENCIES.

1. General.

a. Radiological emergency procedures should be posted in usage and storage areas, will be immediately available to personnel at all times, and are required to prevent, control or reduce accidental radiation exposure and/or contamination to workers and the public.

b. All radiation workers will be knowledgeable in the emergency procedures and relative radiotoxicity and health hazards of the radionuclides in their possession.

c. The most senior individual present will assume control of the situation and direct activities until relieved by the RSO. The exact actions and sequence of actions to be taken will be determined by the nature of the emergency.

2. Notifications. All radiological emergencies will be immediately reported to the SHEM and the RSO, who will:

a. Respond to supervise the elimination of radiological hazards to personnel, equipment and the environment; and

b. Initiate, make, or coordinate all follow-up actions, investigations, reports and notifications with the

cooperation of the individual(s) involved.

3. Minor spill (minimum hazard).

a. Notify all individuals in the area that a spill has occurred.

b. Using protective attire, confine and control the spill. Cover a liquid spill with absorbent material and a dry spill with dampened absorbent material. Neutralize the spill, if required.

c. Mark off the contaminated area with tape, chalk, rope, etc. and control and restrict access to the area.

d. Notify the RSO and SHEM.

e. Establish a plan and start decontamination procedures.

4. Major spills involving radiation hazards.

a. Notify all individuals not required to control the spill to immediately vacate the room.

b. Eliminate or limit the spread of contamination and the source of radiation by the use of protective attire.

(1) Return the source to a shielded container or location.

(2) Confine and control the spill. Cover a liquid spill with absorbent material and a dry (powder) spill with dampened absorbent material. Neutralize the spill, if required.

(3) Turn off all fans.

c. Vacate the room. Ensure that all access doors are closed, secured and controlled to prevent access to the room.

d. Notify the RSO and SHEM.

e. Monitor all individuals suspected of contamination and decontaminate individuals who are contaminated.

5. Accidents involving radioactive aerosols.

a. Notify all individuals in the area that a radioactive aerosol accident has occurred and to immediately vacate the room.

b. Hold breath, cover the container dispersing the aerosol and vacate the room.

c. Ensure that all access doors are closed, secured and controlled to prevent access to the room.

d. Notify the RSO and SHEM.

e. Monitor all individuals suspected of contamination and decontaminate individuals who are contaminated.

6. Personal injury involving radioactive materials.

a. Minor injury.

(1) Immediately flush or wash the injured area with copious amounts of warm water, manipulating the wound to promote bleeding and good rinsing.

(2) Administer first aid, as appropriate.

(3) Notify the RSO, SHEM and (if required) medical personnel.

b. Major injury.

(1) Notify medical service personnel, the RSO and SHEM. Remain with the injured individual until relieved by the RSO and provide radiological hazard information to medical service personnel.

(2) Administer appropriate first aid to the individual as the medical stability of the individual takes precedence over the contamination. If feasible, flush or wash the injured area with warm water several times, cover the wound with absorbent material and then with a plastic covering to prevent cross-contamination.

7. Equipment that produces ionizing radiation. Disconnect the electrical power supply to the unit, perform the emergency procedures specified in the operator's manual and notify the RSO.

8. Lost or missing radioactive materials or sources. Immediately report to the RSO the loss, missing or theft of any radioactive material or radiation source.

9. Fire procedures.

a. If a fire extinguisher is readily available, radiological hazards do not exist, and the fire is small and controllable, attempt to extinguish the fire.

b. Activate the fire alarm to evacuate the building and summon the Fire Department.

c. Initiate the Emergency Evacuation Plan.

d. Contact or leave a message for the RSO and SHEM.

e. Locate the Officer-in-Charge of the responding Fire Department and provide radiological information.

S. RESERVED FOR FUTURE USE.

T. DEFINITIONS.

Activity is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

Adult means an individual 18 or more years of age.

Airborne radioactive material means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

Airborne radioactivity area means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations (1) in excess of the derived air concentrations (DACs) specified in Appendix B, 10 CFR 20.1001 - 20.2401, or (2) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology and the benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of radioactive materials in the public interest.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. ALI values

for intake by ingestion and by inhalation of radionuclides are in Table 1, Columns 1 and 2 of Appendix B, 10 CFR 20.1001 - 20.2401.

Authorized User means an individual who, by virtue of training and experience with radioactive material, has been authorized by the RSC to possess and use radioactive material for a given purpose. This individual has ultimate responsibility for the safe use and handling of radioactive material and for proper precautionary measures to protect himself and others from unwarranted exposure to radiation. This individual may dictate such rules, procedures, or other restrictions as deemed necessary to effect the use and proper handling of radioactive material.

Becquerel (see Units of Radioactivity).

Bioassay (radiobioassay) means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Co-Authorized User means an individual with adequate radiation safety training and experience with radioactive materials to qualify as an Authorized User. This individual is specified on an Authorized User's Radiation Authorization and assumes the responsibilities of the Authorized User in his absence.

Committed dose equivalent ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. Does not include contributions from external dose.

Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues, i.e., $H_{E,50} = \Sigma W_T H_{T,50}$. Does not include contributions from external dose.

Contaminated area means any area which is contaminated with radioactive material to levels in excess of specified values which warrant corrective actions.

Controlled area means an area, outside of a restricted areas but inside the site boundary, to which access is limited in order to protect individuals against undue risks from exposure to radiation or radioactive materials.

Curie means that amount of radioactive material which disintegrates at the rate of 37 billion atoms per second. See Units of Radioactivity.

Declared pregnant woman means a female radiation worker who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose equivalent (H_d) is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2) applied to external whole body exposure.

Derived air concentration (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B to 10 CFR 20.1001 - 20.2401. The DAC is determined by dividing the ALI for any given radionuclide by the volume of air breathed by an average worker during a working year (2,400 m^3).

Dose or radiation dose is (1) a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent and (2) the amount of energy deposited in body tissue due to radiation exposure.

Dose equivalent (H_T) is the product of the absorbed dose in tissue (rads or grays), quality factor (Q), and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Dosimeter means any personal device used to measure an individual's exposure to radiation, i.e., TLD badge, film badge, TLD ring, pocket dosimeter.

Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (W_T) applicable to each of the body organs or tissues that are irradiated, i.e., $H_E = \Sigma W_T H_T$. The units of effective dose equivalent are the rem or sievert (Sv).

Embryo/fetus means the developing human organism from conception until the time of birth.

Equipment that produces ionizing radiation means any piece of equipment that contains radioactive material, regardless of activity, x-ray machine, fluoroscope, particle accelerator or any similar device that produces ionizing radiation.

Exposure means being exposed to ionizing radiation or to radioactive material.

External dose means that portion of the dose equivalent received from radiation sources outside the body.

External exposure means the dose of radiation received by an individual from a source of ionizing radiation outside the body.

Extremity means the hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Eye dose equivalent applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Fixed radioactive contamination means radioactive material that cannot be readily removed from a surface by nondestructive means, such as casual contact, wiping, brushing or washing.

Gray (see Units of Radiation Dose).

Hazardous materials means those materials designated as hazardous by the EPA regulations in 40 CFR Part 261 and for local waste disposals, the State of Nevada or Clark County.

High radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.100 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Internal dose means that portion of the dose equivalent received from radioactive material taken into the body.

Internal exposure means the dose of radiation received by the internal organs of the body from radionuclides ingested, inhaled, or absorbed into the body.

Ionizing radiation means any radiation capable of displacing electrons from atoms or molecules, thereby producing ions.

Label means any written, printed, or graphic materials, displayed on or affixed to containers of hazardous materials.

Leak test means a nondestructive test in which a wipe is taken from the surface(s) of a sealed source or a device in which the sealed source is permanently or semi-permanently mounted or stored to determine accumulated radioactive contamination. Leak tests may be taken by a variety of techniques depending on the source, radionuclide, method of analysis, mounting, etc.

Licensed material means source material, special nuclear material or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the NRC. Licensed material does not include naturally occurring radionuclides and accelerator produced radionuclides.

Limits (dose limits) means the permissible upper bounds of radiation doses.

Lost or missing radioactive material means radioactive material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

Member of the public means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

Microcurie means that amount of radioactive material which disintegrates at the rate of 37 thousand atoms per second.

Millicurie means that amount of radioactive material which disintegrates at the rate of 37 million atoms per second.

Minor means an individual less than 18 years of age.

Mixed radioactive waste means radioactive waste material which also contains hazardous material.

Monitoring (radiation monitoring, radiation protection monitoring) means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

Occupational dose means the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Occupational exposure means exposure incurred as a result of an individual's employment or duty.

Personnel monitoring devices or equipment means devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

Planned special exposure means an infrequent, preplanned exposure to radiation, separate from and in addition to the annual dose limits.

Rad (See Units of Radiation Dose).

Radiation (ionizing radiation) means alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this manual, does not include non-ionizing radiation, such as radiowaves or microwaves, or visible, infrared, or ultraviolet light.

Radiation accident/incident means an unforeseen event, either actual or suspected, involving exposure or contamination of man or the environment by ionizing radiation and which occurs over a short period of time, from seconds to several days. Chronic occupational or other long-term exposure is not considered accidental.

Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation Authorization means an authorization for the nonhuman use of radioactive material issued by the RSC to an individual to receive, possess, store, use, and transfer radioactive material which is subject to the conditions and limitations specified in the authorization, this manual and the NRC license.

Radiation worker means an individual who, under the supervision of a Authorized User, performs certain routine duties involving the use of radioactive material or equipment producing ionizing radiation. These individuals have been trained in the safe use and handling of radioactive materials, hazards associated with exposure to radiation, and precautionary measures to protect themselves and others from unwarranted exposure to radiation.

Radioactive contamination means unwanted radioactive material, either fixed or non-fixed, that is on personnel and/or their attire and on the surfaces of, or in, equipment and work areas.

Radioactive material means any material which undergoes spontaneous nuclear disintegration with emission of corpuscular or electromagnetic radiation. Includes accelerator produced isotopes, naturally occurring isotopes, special nuclear material, byproduct material, source material, and items contaminated with radioactive material. For transportation purposes, radioactive material means any material having a specific activity greater than 0.002 microcuries per gram.

Radioactive waste means unwanted radioactive material or contamination on or of property or items to the extent that decontamination is economically unsound; includes waste due to

the production, possession and usage of radioactive materials and surplus radioactive material whose sale, transfer or donation is prohibited.

Radioactivity means a natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.

Rem (See Units of Radiation Dose).

Removable (non-fixed) contamination means radioactive material that can be readily removed from a surface by nondestructive means, such as casual contact, wiping, brushing or washing.

Research and development means (1) theoretical analysis, exploration, or experimentation or (2) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials and processes. Does not include the internal or external administration of byproduct material, or the radiation therefrom, to human beings.

Respiratory protective device means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

Restricted area means an area, which is posted, access to which is limited in order to protect individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Sanitary sewerage means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

Sealed source means any radioactive material that is encased in a capsule, sealed between layers of nonradioactive material or firmly fixed to a nonradioactive surface by electroplating or other means designed to prevent leakage or escape of the radioactive material under normal and most accidental conditions related to the use of the source.

Shallow-dose equivalent (H_S), which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.

Sievert (See Units of Radiation Dose).

Survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Transport index (TI) means the dimensionless number (rounded up to the first decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as the number expressing the maximum radiation level in millirem per hour at 1 meter from the external surface of the package.

Units of Radiation Dose.

Gray (Gy) is the SI unit of absorbed dose for any type of radiation. One gray is equal to an absorbed dose of 1 Joule/kilogram (100 rads).

Rad is the special unit of absorbed dose for any type of radiation One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).

Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor, Q (1 rem = 0.01 sievert).

Sievert (Sv) is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor, Q (1 Sv = 100 rems).

Units of Radioactivity. Radioactivity is expressed in the special unit of curies (Ci) or in the SI unit of becquerels (Bq), or their multiples, or disintegrations (transformations) per unit of time.

One becquerel = 1 disintegration per second (s^{-1}).

One curie = 3.7×10^{10} disintegrations per second
= 3.7×10^{10} becquerels
= 2.22×10^{12} disintegrations per minute.

Unrestricted area means an area, access to which is neither limited nor controlled.

Very high radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. Note: At very high doses received at high dose rates, units of absorbed dose (i.e., rads and grays) are appropriate, rather than unit of dose equivalent (i.e., rems and sieverts).

Visitor means an individual requesting access to a controlled, restricted area where radioactive materials are used or stored who has not been trained to the level required to permit unescorted access.

Whole body means, for purposes of external exposure, the head, trunk, (including male gonads), arms above the elbow, or legs above the knee.

Whole body dose is the sum of the annual deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

U. REFERENCES.

Title 10, Code of Federal Regulations
Rules and Regulations of the Nuclear Regulatory Commission

Title 49, Code of Federal Regulations
Rules and Regulations of the Department of Transportation

USNRC Regulatory Guides

8.7	Instructions for Recording and Reporting Occupational Radiation Exposure Data
8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program
8.10	Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Reasonably Achievable
8.13	Instruction Concerning Prenatal Radiation Exposure
8.23	Radiation Safety Surveys at Medical Institutions
8.25	Air Sampling in the Workplace

USNRC Regulatory Guides (continued)

8.29	Instruction Concerning Risks From Occupational Radiation Exposure
8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses
8.35	Planned Special Exposures
8.36	Radiation Dose to the Embryo/Fetus
8.37	ALARA Levels for Effluents from Materials Facilities

American National Standards Institute (ANSI) publications

N13.5-1972	Performance Specifications for Direct Reading and Indirect Reading Pocket Dosimeters for X and Gamma Radiation
N13.11-1983	Criteria for Testing Personnel Dosimetry Performance
N323-1978	Radiation Protection Instrumentation Test and Calibration

DOE/EH-0027 - Department of Energy Standard for the Performance Testing of Personnel Dosimetry Systems - DOE Laboratory Accreditation Program for Personnel Dosimetry Systems, December 1986.

DOE/EH-0026 - Handbook for the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems - DOE Laboratory Accreditation Program for Personnel Dosimetry Systems, December 1986.

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