70-08

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 SNM-7

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

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

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

A. 505 King Avenue, Columbus, OH
B. 1425 Plain City-Georgesville Road
West Jefferson, OH

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Gregory Fess

TELEPHONE NUMBER
(614-424-7923)

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 (refer to text)
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 (refer to text)

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE (refer to text)

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS (refer to text)

9. FACILITIES AND EQUIPMENT (refer to text)

10. RADIATION SAFETY PROGRAM (refer to text)

11. WASTE MANAGEMENT (refer to text)

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
FEE CATEGORY 3.L.
AMOUNT ENCLOSED $ 2200

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
Gregory Fess Licensing Coordinator	Gregory Fess	12/23/93

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		

APPROVED BY	DATE

Revision 0

BATTELLE MEMORIAL INSTITUTE

RENEWAL APPLICATION BMI 12-93

FOR SNM-7

DECEMBER 1993

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INTRODUCTION

This license renewal is being submitted using the guidance and format of the *Standard Review Plan for Type A Licenses of Broad Scope* for use with Proposed Revision 2 of Regulatory Guide 10.5, issued February 1985 with the designation FC 408-4.

As indicated to the NRC in earlier correspondence, and as reflected in the recently issued SNM-7, Amendment 4 (October 5, 1993), a number of changes have occurred at the Battelle Memorial Institute that affect the contents of the license. Large scale research activities involving irradiated fuel material and activated reactor materials and components have essentially ceased at the West Jefferson and King Avenue sites. Battelle continues to decontaminate areas and buildings at the King Avenue and West Jefferson facilities as part of the Decontamination and Decommissioning (D&D) Operations project to radiologically release Battelle facilities that were used chiefly in support of U.S. Government objectives for over 40 years. This project is referred to as the Battelle Columbus Laboratories Decommissioning Project (BCLDP).

In this document, we distinguish between ongoing licensed Battelle activities, which is primarily R&D work and referred to as Battelle Columbus Operations (BCO), and those operations that consist exclusively of the D&D activities (BCLDP).

This renewal application includes information about the current status of Battelle's organizational structure and its operation pursuant to SNM-7. As part of this licence renewal process, Battelle submitted its final *"Decommissioning Plan for the Battelle Memorial Institute Columbus Operations"* (Decommissioning Plan) to NRC on May 25, 1993. The plan was approved by the NRC by letter dated Decmber 6, 1993. It is included (without attachments) as Appendix E.

Licensed radiological work at Battelle now focuses primarily on research and development (R&D) activities using byproduct materials in toxicology and tracer studies, agriculture applications, and radiography. All NRC regulated SNM fuel has been shipped off-site. Only minimal quantities of SNM (12g of Pu-238 and 18g of Pu-239) remain in secure storage on the SNM-7 inventory from previous R&D work for DOE. This reduction in licensed SNM is consistent with our decision to reduce SNM and source material R&D activities and focus on byproduct material R&D. As you are aware, we are continuing D&D operations as part of the BCLDP. Investigation of methods to dispose of the 12g of Pu-238 and 18g of Pu-239 is currently being explored. Also, up to one (1) gram of SNM as U-235 is requested for small quantity R&D under the byproduct license. The source material inventory will consist primarily of depleted uranium (DU) and thorium as residual contamination and uranium incorporated into shielding in shipping containers; e.g., Ir-192 used in Radiography experiments.

As a result of the revised use of licensed material, we are submitting this renewal application to authorize the following:

- Receipt, possession, and use of byproduct material in laboratories continuing to conduct research and development activities; and

- Possession only for diffuse special nuclear, source, and byproduct material as residual contamination being removed in laboratories that are part of the BCLDP. Authorization is also requested for possession of discrete quantities of special nuclear and source material for instrument calibration, R&D, and BCLDP decontamination activities.

This submittal also addresses the change in the organization of Battelle related to the functions under this license. Battelle continues to own and operate the facilities covered by SNM-7. However, due to organizational changes since the last license renewal amendment, the applicant/licensee is now designated as Battelle Memorial Institute, instead of the Battelle Columbus Division.

Battelle has an extensive emergency program in existence addressing all considerations associated with contingency planning. The emergency documents are not included in the appendices because of their voluminous nature. However; the documents, identified in Section 10.14, are available for review.

To keep clear the two major respective radiation protection roles of the operations associated with this application, there are separate radiation protection programs designed for each. The reviewer is referred to the respective appendices for these programs. Appendix C contains the BCO Radiation Safety Manual as reference for the BCO Radiation Protection Program, and Appendix D contains the Radiation Protection Program for the BCLDP, the reference document used for the D&D Program.

Quality Assurance Programs are incorporated to ensure the accountability and effectiveness of the Radiation Protection Programs for both BCO and BCLDP operations. The programs include guidance on records requirements, and required quality. Annual reviews and appraisals of operations are performed by the Radiological Safety Committee, appraisals by the Radiological Safety Officer conducted at sufficient frequencies to ensure that exposures to licensed materials are maintained ALARA, and independent programmatic and activity assessments of the BCLDP D&D Program by the Environmental Systems and Technology Division (ESTD) Quality. These appraisals and audits are also performed to ensure that the radiological safety practices of the Radiation Safety Services staff and authorized researchers comply with applicable regulations, guidelines, and accepted practice. On an annual basis, Radiation Safety Services performs a review of each active Radioactive Material Application (RMA) to ensure all information is accurate. In addition to RMA reviews, Radiation Safety Services routinely reviews laboratory procedures and recordkeeping during surveys as prescribed in the BCO Radiation Safety Manual (Appendix C). In addition, a Regulatory Compliance and Oversight Program performs appraisals and surveillances of all BCLDP activities. ESTD Quality shall perform an annual independent assessment of license related activities within its division.

Battelle has complied with NRC regulations associated with financial assurance by properly filing its Decommissioning Funding Plan with this renewal application. Decommissioning of these facilities will be conducted under a cost share agreement with the U.S. Department of Energy (DOE), under which DOE is contractually obligated to fund 100 percent of the pre-D&D Surveillance and Maintenance costs and 90 percent of all other D&D costs. Radioactive waste from the BCLDP will be disposed of at DOE-owned and/or DOE-approved disposal sites. The BCLDP is included in DOE's Environmental Restoration and Waste Management Five Year Plan and DOE has approved the technical, cost and schedule baseline for completion of all facilities. Decommissioning costs, including decontamination and waste disposal, are estimated to be $149 million dollars of which $66 million dollars have already been spent through FY 1993. Final cost estimates for each building are being reviewed.

The information provided in this renewal application currently addresses the specific items described in the Standard Review Plan for Applications for Type A Licenses of Broad Scope. However, Battelle's research work does not remain constant over time, and it can be expected that changes will be necessary in areas covered by the license. In order to facilitate appropriate changes in Battelle's programs and conduct of work with radioactive materials without prior notification to the NRC under the license, Battelle may make such changes where required by amendments or additions to NRC regulations, are minor or administrative in nature, or where the Radiological Safety Committee has reviewed and approved a proposed change and determined it to be otherwise consistent with NRC regulations and this license. Also, formalized changes to the Radiological Safety Committee Charter may be made, providing the changes do not compromise the radiation safety program and are incorporated pursuant to Radiological Safety Committee (RSC) review and approval. Supporting documentation may be modified as stated above or upon written analysis that the modification does not decrease the effectiveness of the radiation protection program in performing its function. This analysis will be retained on file with the Radiological Safety Officer and the NRC Licensing Coordinator. Program possession limits may be decreased upon written analysis that the modification does not decrease the effectiveness of the radiation protection program to perform its function. This analysis will be retained on file with the Radiological Safety Officer and the NRC Licensing Coordinator. The NRC will be notified in writing within 60 days of this decrease.

1.0 LICENSE INFORMATION

This is a request for renewal of an existing license. This renewal is requested for a period of 10 years.

2.0 APPLICANT'S NAME AND MAILING ADDRESS

Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

The previous holder of SNM-7 was identified as the Battelle Columbus Division, a wholly owned division of the Battelle Memorial Institute.

3.0 LOCATIONS OF USE

There are two locations of possession and use.

- The King Avenue laboratories at 505 King Avenue, Columbus, Ohio
- The West Jefferson facilities, approximately 17 miles west of Columbus and one mile south of Route 70 on Route 142.

Diagrams of these sites are provided in Figures I and II.

4.0 PERSON TO BE CONTACTED ABOUT APPLICATION

The person to be contacted about this license is the Battelle NRC Licensing Coordinator, Gregory Fess. His telephone number is (614) 424-7923. Mr. Fess is a full-time Battelle staff member.

5.0 MATERIAL TO BE REQUESTED

Element and mass number	Chemical and/or physical form	Maximum amount which will be possessed
Special Nuclear Material		
A. Uranium enriched in the U-235 isotope—irradiated	A. Any	A. 100 grams of U-235 plus the associated and unseparated plutonium
B. Uranium enriched in the U-235 isotope-irradiated	B. Any	B. 1 gram of U-235 plus the associated and unseparated plutonium
C. Uranium enriched in the U-235 isotope—unirradiated	C. Any	C. 50 grams of U-235
D. Uranium enriched in the U-235 isotope-unirradiated	D Any	D. 10 grams of U-235
E. Plutonium (any principal isotope Pu-238-244)	E. Any	E. 1 gram total
F. Plutonium (Pu-238 principal isotope)	F. Sealed Sources	F. 12 grams
G. Plutonium (Pu-239 principal isotope)	G. Oxide	G. 18 grams
Source Material		
H. Any source material	H. Any	H. 300 kilograms total

Element and mass number	Chemical and/or physical form	Maximum amount which will be possessed
Byproduct Material		
I. Any byproduct material	I. Irradiated fuel material, activated reactor materials and components	I. 10000 Ci total, not more than 1000 Ci of any one radioisotope (Excluding Items J through S below)
J. Hydrogen-3	J. Any	J. 500 Ci
K. Polonium-210	K. Any	K. 500 Ci
L. Californium-252	L. Any	L. 500 Ci
M. Sulfur-35	M. Any	M. 1000 Ci
N. Chlorine-36	N. Any	N. 1000 Ci
O. Iodine-131	O. Any	O. 1000 Ci
P. Iodine-129	P. Any	P. 60 Ci
Q. Cobalt-60	Q. Any	Q. 5000 Ci
R. Cesium-137	R. Any	R. 5000 Ci
S. Strontium-90	S. Any	S. 5000 Ci
T. Carbon-14	T. Any	T. 10 Ci
U. Any byproduct material	U. Any	U. 500 Ci total, not more than 50 Ci of any one radioisotope
V. Iridium-192	V. Sealed Sources	V. 400 Ci total, no single source to exceed 130 Ci
W. Cobalt-60	W. Sealed Sources	W. 100 Ci total, no single source to exceed 50 Ci

6.0 PURPOSE FOR USE OF LICENSED MATERIAL

6.1 Special Nuclear Material

Items A and C are principally possessed in the form of residual contamination present in the West Jefferson north site facilities and arise directly from research and development activities as defined in 10 CFR 30 and 70. The primary location is in the JN-1, Hot Laboratory, located at the West Jefferson north site. Possession and use of small quantities of SNM in Items B and D are included to be utilized in research and development at both the King Avenue and West Jefferson north sites as defined in 10 CFR Parts 30 and 70. Item E, Pu (238-244) will be used for calibration sources and R&D as defined in Parts 30 and 40 at both the King Avenue and West Jefferson north sites. Items F and G are currently in secure storage at the West Jefferson north site, and disposal options are being explored.

6.2 Source Material

Item H is possessed as residual contamination at the King Avenue site under the control of the BCLDP D&D program, primarily in buildings 1, 2, and 3. In addition, small quantities will be used as calibration and check sources for radiation detection instruments at both the King Avenue and West Jefferson sites. Up to 200 Kg of the material may be possessed as depleted or natural uranium, encapsulated in steel storage and shipping containers; e.g., will be used for shielding of Ir-192, primarily at the King Avenue site. Natural and/or depleted uranium may be possessed in any licensed radiography projector model or any experimental projector model used for R&D. Principal locations for this use will also be at the King Avenue site. A small amount may also be retained at both sites for R&D as defined in 10 CFR Parts 30 and 40.

6.3 Byproduct Material

Items I-S are residual and discrete materials remaining after R&D work principally performed at the West Jefferson north site. Item T authorizes field studies at the West Jefferson site, including the application of up to 3 Ci of C-14 on dedicated ground plots. Per letter to Leland Rouse, U.S. NRC dated August 5, 1988, Item T is also associated with the analyses of C-14 radiolabelled materials generated from the field studies at the King Avenue and West Jefferson facilities. Item U is now associated with general R&D activities as defined in 10 CFR Parts 30 and 40 and with some residual and discrete material arising from previous R&D work. The request for 50 Ci of any one radioisotope is to allow for possible extended storage prior to the opening of a

low level radioactive waste (LLRW) site for disposal within the Midwest Compact. The materials listed in V and W are materials used for on-going R&D in the Radiography Laboratory at the King Avenue site on a primary basis.

7.0 INDIVIDUALS RESPONSIBLE FOR RADIATION SAFETY PROGRAM -- THEIR TRAINING AND EXPERIENCE

The Battelle Radiation Protection Program is administered by the BCO Radiation Safety Services, and in association with review of relevant operations by the Radiological Safety Committee. Radiation Safety Services is directed by the Radiological Safety Officer, a full-time assignment. BCO Radiation Safety Services has a staff of four radiation protection technicians. The program provides guidelines and controls for radioactive materials licensed by the Nuclear Regulatory Commission and compliance oversight for Department of Energy funded activities under BCLDP. In addition, the DOE associated BCLDP D&D program has a full-time Safety, Health and Environmental Support Manager and functional support units dedicated to radiological considerations associated with this decontamination and decommissioning program. There are approximately 20 full-time managers, supervisors, and technicians directly associated with the BCLDP program. Comprehensive discussion regarding the overall radiation safety program is provided in Section 10.0, and in Appendixes C and D.

7.1 Radiological Safety Officer

The Radiological Safety Officer (RSO) is the health physicist appointed by the Battelle Chief Executive Officer (CEO) to represent and report directly to him in matters of radiological safety. The RSO has the responsibility and authority for initial review of proposed operations to determine the necessity of review by the Radiological Safety Committee (RSC). The RSO is authorized to approve operations that do not require RSC review and interdict operations that present an unacceptable radiological hazard or do not comply with Federal, State, or Battelle regulations and requirements. The RSO directs the activities of Radiation Safety Services to ensure that all radiological operations conducted by Battelle's Columbus based divisions are conducted safely and that personnel exposures are maintained As Low As Reasonably Achievable (ALARA). The RSO's responsibilities include oversight of the BCLDP. Qualifications for the Radiological Safety Officer (RSO) position are: Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines, with a minimum of five (5) years experience in operational health physics,

demonstration of sufficient judgement and technical capability to conduct and review radiological safety operations. Appendix A contains the biographical information for the RSO. Both the RSO and the RSC have the authority and responsibility to stop the operation of a facility or an experiment believed to constitute an unacceptable potential for radiological hazard.

7.2 BCLDP Safety, Health and Environmental Support Manager

The Safety, Health and Environmental Support (SH&ES) Manager directs the BCLDP Radiation Protection Program. This department provides health physics and radiation protection support for the BCLDP decontamination program. The manager directs a staff of over 20 people associated with radiation protection. Minimum requirements for this position require a Bachelor's degree in Health Physics, Industrial Health and Safety or Environmental Engineering and generally 10 to 15 years related experience, with 8 to 10 years of this experience in the performance of health, safety, and environmental compliance functions for organizations involved in the control of nuclear materials. Appendix A contains the biographical information for the SH&ES Manager. The SH&ES Manager currently serves as the Radiation Protection Manager for the BCLDP.

7.3 Radiation Protection Technicians

Qualifications for BCO Radiation Protection and BCLDP Health Physics technicians require field experience in conducting radiation surveys and inspections. Both the BCO and BCLDP radiation protection programs require ANSI N3.1 certified technicians for the senior positions. BCO and BCLDP may evaluate and wave the ANSI N3.1 one-year nuclear power plant experience requirement for senior technician positions based on other experience.

7.4 Radiological Safety Committee

The purpose of the Radiological Safety Committee (RSC) is to provide technical information and a broad experience base for the evaluation of radiological safety in proposed and on-going research programs using licensed materials. Specific responsibilities include advising the office of the Chief Executive Officer (CEO) in matters of radiological hazards, determining the types of radiological work that must be reviewed, evaluating the experimenter's hazard analysis of proposed work, and assuring the CEO that the potential hazards have been reduced to acceptable levels. The RSC has the authority to interdict operations in facilities or experiments where they believe unacceptable

radiological hazards exist. The RSO is authorized to approve operations that do not require RSC review. Both the RSO and the RSC have the authority and responsibility to stop the operation of a facility or an experiment believed to constitute an unacceptable potential for radiological hazard. Qualifications for Radiological Safety Committee (RSC) membership include: a Bachelor's degree in one of the physical sciences, biological sciences, or engineering disciplines, a minimum of five (5) years experience in a technical discipline related to radiation and radioactive materials, demonstration of sufficient judgement and analytical capability to conduct and review radiological safety analyses. Biographical information of committee members is included in Appendix A.

7.5 NRC Licensing Coordinator

The NRC Licensing Coordinator is the legal advisor designated by the CEO as responsible for licensing compliance for activities conducted under the license.

The NRC Licensing Coordinator organizes nuclear regulatory compliance activities related to the Battelle nuclear license. The Coordinator maintains the license, prepares and approves amendments, and renewals as required. The Coordinator provides regulatory information and guidance to line management and research staff. The Coordinator also maintains liaison with NRC on all regulatory matters. Appendix A contains the biographical information for the NRC Licensing Coordinator. Qualifications for this position include a bachelor's degree and a minimum of five (5) years' experience in nuclear licensing activities.

8.0 TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS

As stated in the Standard Review Plan for Applications for Type A Licenses of Broad Scope, on which this application is based, discussion of training for individuals working in or frequenting restricted areas is included in Item 10, specifically 10.12.

9.0 FACILITIES AND EQUIPMENT

Past operations were focused to a great degree at the W. J. North site predominately at the Hot Laboratory. The Hot Laboratory stopped active research activities with radioactive materials in the mid 1980's. During the active operation of this laboratory,

radiological facilities and equipment were used primarily for reactor fuel research. Subsequent D&D activities consist primarily of radiological surveillance and facility maintenance to ensure radiological safety of buildings, facilities, and equipment.

Radiological work at Battelle now focuses primarily on research and development (R&D) activities using byproduct materials in toxicology and tracer studies, agriculture applications, and radiography. All NRC regulated SNM fuel has been shipped off site. This reduction in licensed SNM is consistent with our decision to reduce SNM R&D activities and focus on byproduct material R&D. In addition, Battelle continues decontamination and decommissioning (D&D) operations at the King Avenue and West Jefferson facilities as part of the Battelle Columbus Laboratories Decommissioning Project (BCLDP), which is primarily funded by the U.S. Department of Energy (DOE) and, in part, by Battelle. In this document, we distinguish between ongoing licensed Battelle activities, which are referred to as Battelle Columbus Operations (BCO), and those operations that consist exclusively of the decontamination and decommissioning activities (BCLDP). At the conclusion of the BCLDP, byproduct R&D work will continue as described in Section 6.0 and the source material and SNM inventories (used for shielding, R&D instrument calibration purposes) will be small. Accordingly, facilities and equipment associated with BCO on-going research activities will be retained.

9.1 Primary Use Organizations/Facilities

Battelle maintains and operates the following organizations with permanent facilities for conducting research programs utilizing radioactive materials. Work is conducted within the following organizational units as indicated in Figures III, IV, V, VI, VII, and VIII, as provided in Appendix F. The divisions utilizing radioactive materials are outlined in bold.

9.1.1 Health Division

There are four groups within the Health Division conducting a variety of operations that involve the use of radioactive byproduct materials, both at King Avenue and West Jefferson. The Core Biotechnology Group, the Preclinical Drug Development Group, the Agrochemical Product Development Group, and the Medical Research and Evaluation Facility. The laboratories at the West Jefferson site are located at the JM (middle) complex at the greenhouse and experimental plot. The King Avenue site includes laboratories in Buildings 5, 6, 7, and 7C.

These groups conduct various studies using material such as C-14, H-3 and P-32. Across the Health Division, there are several labs with analysis equipment such as liquid scintillation counters and gas chromatographs containing sealed sources.

Restricted areas are incorporated in each of the lab areas. Control measures include ventilation control, containment, and surveillance for both fixed and transferable contamination. The control measures also include the use of protective clothing and respiratory equipment where applicable. Signs and labels are used to properly identify areas, consistent with 10 CFR Part 20 requirements. All restricted areas are surveyed and monitored consistent with BCO Radiation Safety Program requirements.

The use of all radioactive material within the Health Division is governed by standard operating procedures which conform to the guidelines set forth by the Battelle Radiation Safety Services office. Procedures used by the respective groups to perform operations with radioactive materials are available in the Health Division Office for review.

9.1.2 Commercial and Industrial Technology Division

There are two groups within this division that operate research facilities for conducting radiographic research in quality assurance and non-destructive testing applications. The Engineering Physics and Non-Destructive Examination Group within the Engineering Mechanics Department has laboratory areas devoted exclusively to radiographic work. These labs are located in buildings A, 1, and 9 at the King Avenue site. These labs contain sealed sources and real time scanning and image processing systems. The Polymer Science and Technology Group within the Polymer Center operates a lab in Building 7 for the exploration of free air volume in polymers.

The Engineering Physics and Non-Destructive Examination Group laboratories utilize sealed, e.g., Co-60 and Ir-192 for the various radiographic-related research operations. The Polymer Research Lab uses Na-22 in a non-destructive method for evaluation of polymeric materials.

There are two groups within this division that provide research facilities for (1) conducting radiographic services and (2) conducting research in the use of radioactive materials in quality assurance applications also in non-destructive testing applications.

In the Radiography Laboratory, there are three laboratory areas that are devoted exclusively to radiographic work. These labs are located in buildings A and 1, at the King avenue campus. One lab contains approximately 300 square feet of floor space housing general purpose x-ray machines and isotope sources. A second lab contains approximately 400 square feet of floor space used for research associated with real time scanning and image processing. The third lab contains approximately 400 square feet of floor space also used for image processing and related operations.

Restricted areas for radiographic operations are bounded by barriers, containment, interlocks and associated operational procedures to ensure that exposures are ALARA. In addition, BCO Radiation Safety Services performs routine inspections in these facilities. Restricted areas for the Polymer Research Laboratories are bounded by barriers and posted in accordance with 10 CFR Part 20 requirements. A locked housing within the restricted areas contains the Na-22 source used in the research activities.

The use of radioactive materials within the Commercial and Industrial Technology Division is governed by standard operating procedures which conform to the guidelines set forth by the Battelle Radiation Safety Services office.

Procedures used by the Radiography Laboratory and the Polymer Research Laboratory are available for review in the respective laboratories.

9.1.3 National Security Division

There is one group within this division that may incorporate small sealed sources of radioactive material in research operations.

The Chemical and Biological Defense Group operates a laboratory in JN-4 at West Jefferson where chemical detection instruments may use small (uci) sealed Am-241 sources as part of the detection

apparatus within the instruments and gas chromatographs incorporating Ni-63 sources. Unencapsulated radioactive materials are not normally anticipated to be used in research operations within this facility.

Operations in the laboratory are sporadic in nature with respect to the use of instruments containing sealed sources.

Since the instruments contain small sealed sources of radioactive materials, restricted areas, as such, are not required. However, the instruments are used under controlled conditions by the researchers and stored under controlled conditions when not in use.

The use of the sealed sources in the laboratory conform to the guidelines of and are under the purview of the Battelle Radiation Safety Services office.

9.1.4 Environmental Systems and Technology Division

There are two groups within this division where small quantities of radioactive materials are used in research applications on a limited basis; the Environmental Technology Group (ETG) and the Atmospheric Science Applied Technology Group (ASATG). Both groups have laboratory facilities at the King Avenue Campus in buildings 5, 6, and 7.

The Battelle Columbus Laboratories Decommissioning Project (BCLDP) is also a program within the Division for the express purpose of decontaminating and decommissioning radioactively contaminated facilities at both the King Avenue and West Jefferson sites under contract for DOE. Facilities undergoing or scheduled for decontamination are located in buildings 1, 2, 3, 4, 5, 6, and 7 at King Avenue and in buildings JN-1, JN-2, and JN-3 at the West Jefferson North site. The Radioanalytical Lab (RAL) located in Building JN-2 performs analyses for the BCLDP. This laboratory may remain active after the conclusion of the BCLDP to provide services for other BCO research units and their clients.

Typical operations for both the Environmental Technology and the Atmospheric Science Applied Technology groups occasionally involve the incorporation of trace quantities e.g.; C-14, to study

transport and migration in various environmental media. These groups also use gas chromatographs incorporating Ni-63 electron capture detectors.

Typical operations associated with the BCLDP include comprehensive surveillance and maintenance, decontamination, and waste management operations.

Restricted areas for the Environmental Technology, Atmospheric Science Applied Technology groups, and the BCLDP include ventilation control, containment, and surveillance for both fixed and transferable contamination. The control measures also include the use of protective clothing and respiratory equipment where applicable. Signs and labels are used to properly identify areas consistent with 10 CFR Part 20 requirements for ETG and ASATG areas and consistent with DOE requirements for BCLDP areas.

The use of radioactive materials within the ETG and the ASATG is governed by standard operating procedures which conform to the guidelines set forth by the Battelle Radiation Safety Services office.

The control of radioactive material within the BCLDP is governed by operating procedures which conform to DOE requirements as managed by the BCLDP, Safety, Health and Environmental Department with overview by the Battelle Radiological Safety Officer.

9.1.5 Office of the Chief Financial Officer

The BCO Electronic Services instrument calibration facility reports to the Office of the CEO at the division level. The facility is located in building JN-2, at the north end of the West Jefferson site. The laboratory uses sealed sources for equipment calibrations. All sources are inventoried and leak tested as required. BCO Radiation Safety Services and the BCO Radioactive Waste Management Group are in this division and are responsible for the collection, storage, and shipment of all radioactive waste for BCO operations.

Operations associated with the use of radioactive materials in this division are confined to operations in the Electronics Services instrument calibration facility located in Building JN-2 at the West

Jefferson North site and radioactive waste in BCO-related operations located in Building 7C at the King Avenue campus.

Operations in the Electronics Services instrument calibration facility primarily use sealed sources of Cs-137 and Co-60 for instrument calibrations. Small beta sources, e.g., Sr-90, and alpha emitters; e.g. uranium and thorium are also used to calibrate instruments.

The entire Electronics Services instrument calibration facility is a restricted area, and entrance requirements include access by radiation work permit (RWP) and appropriate radiation worker training and personnel dosimetry. The use of radiation sources in the calibration facility is controlled both by BCO and BCLDP procedures.

9.2 Equipment, Instrumentation, and Calibration Services

Portable radiation surveying instruments suitable for the detection and determination of the types, energy ranges, and intensities of the radiation resulting from licensed activities are provided to radiation protection technicians through the Radiation Safety Services office, and to trained radiation workers through their department management. The BCLDP D&D program also provides instruments to radiation protection technicians associated with this program.

The instruments are serviced and calibrated at intervals not to exceed 12 months in accordance with ANSI N323. BCLDP instruments are calibrated at 6 month intervals. Calibrations may be conducted by on-site personnel, off-site vendors, or according to the Decommissioning Plan for BCLDP operations. Portable survey meters will be response checked daily, or prior to use. Sources used for calibration shall be traceable to the National Institute of Standards and Technology (NIST). The following is a general list of the types and numbers of both portable and non-portable instruments currently being used by BCO Radiation Safety Services and by BCLDP:

Table 9.2-1 General List of BCO and BCLDP
Radiation Protection Instruments

Type of Instrument	Number (BCO)	Number (BCLDP)	Use
GM survey instruments	17	84	contamination measurement
ionization survey instruments	2	24	exposure rate measurement
sodium iodide scintillators	3	17	environmental surveys
alpha detectors	3	65	contamination surveys
BF_3 Neutron	not applicable	2	neutron dose rate
gas proportioned survey instruments	not applicable	15	contamination surveys
plastic scintillator survey instruments	not applicable	20	contamination surveys
gas proportioned sample counters	2	5	smear, air, and environmental samples
air samplers	11	55	quantify airborne concentrations
working area air monitors	not applicable	12	quantify airborne concentrations
effluent air monitors	not applicable	14	quantify airborne concentrations
liquid scintillation counters	1	not applicable	low energy beta smears
multi-channel analyzers (MCA)	not applicable	2	environmental analyses
high-purity germanium detectors	not applicable	4	environmental analyses

10.0 RADIATION SAFETY PROGRAM

The overall radiation safety program is composed of several components, including the RSC, the RSO, the BCO radiation safety program operated by the Radiation Safety Services Office, and the DOE-related BCLDP decontamination and decommissioning (D&D) radiation safety program. The latter functions separately with oversight provided by the RSO. Both the BCO and BCLDP programs contain all of the required radiation safety program functional components, including dedicated radiation protection staff. Discussion of both the BCO and BCLDP radiation safety programs is provided in the BCO Radiation Protection Plan, Revision 1, BCO Radiation Safety Manual, Appendix C and Radiation Protection Program for the BCLDP, Appendix D.

ALARA Program Endorsement

D. E. Olesen, the Battelle Memorial Institute's Chief Executive Officer, emphasized the importance of awareness of the hazards of ionizing radiation in a memo sent to all Battelle staff in December 1992. The memo described Battelle's ALARA program and defined the lines of authority and responsibility for safe radiological practices at Battelle. Because it represents a commitment to understanding the applicable policies and procedures, as well as to compliance with the requirements of the ALARA program, it is reproduced in Exhibit 1 on the following page.

10.1 Radiological Safety Committee

The Radiological Safety Committee serves to provide safety reviews of proposed projects involving radioactive material usage in Battelle Columbus Operations R&D activities. The committee is composed of six to eight Battelle staff members with broad expertise in radiological safety matters. Members are chosen on the basis of their technical expertise and experience. The Radiological Safety Officer is a member of the RSC. The committee has "stop work" authority for unsafe work practices. There are eight criteria associated with the requirement for committee review of operations involving the use of radioactive materials. The complete list of criteria is included in the RSC Charter, Appendix B, attached to this application. The RSC review consists of a formal evaluation of a written request to use radioactive material called a Radioactive Material Application (RMA). The requestor meets with the RSC to answer questions from the committee to facilitate the evaluation process. A quorum consisting of two-thirds of the committee plus the RSO or qualified

EXHIBIT 1

Project Number _____

Internal Distribution

Battelle
... Putting Technology To Work

Date December 8, 1992

To Battelle Columbus Operations Staff

From D. E. Olesen D. E. Olesen

Subject ALARA Program

The purpose of this memo is to tell you about Battelle's ALARA program, to state my commitment to its success, and to ask for your support.

ALARA is an acronym for "As Low as Reasonably Achievable". It is an approach to occupational, public, and environmental protection by which radiation exposures and releases of radioactive material to the environment are managed and controlled to levels as low as reasonably achievable below applicable regulatory limits. In other words, we are committed to go beyond regulatory limits to the lowest practical exposure or contamination level. Even though the current regulatory limits ensure a minimal risk, it is nevertheless prudent to avoid unnecessary exposure.

ALARA is everyone's responsibility. This responsibility begins with the users of radioactive materials and their managers. All radioactive material users, radioactive material principal investigators, and operators of equipment that emit ionizing radiation are required to attend annual radiation safety training and to follow applicable radiation safety requirements. The Division Managers are committed to supporting line management in their efforts to maintain exposure and contamination levels ALARA and to ensuring the deployment of necessary resources to operate a successful program.

The Radiological Safety Officer (RSO) and the Radiological Safety Committee (RSC) serve as agents of the CEO in providing independent oversight of the radiological safety practices at Battelle. Both the RSO and the RSC have the authority and responsibility to stop the operation of a facility or an experiment believed to constitute an unacceptable potential for radiological hazard. The RSC, the RSO and the Environmental Safety and Health Department's Radiation Safety Services (RSS) office are dedicated to advising and assisting staff and visitors with regard to the safe performance of radiological operations and the achievement of ALARA goals. In addition, the RSO and RSS are responsible for developing policies and procedures for maintaining radiation exposures ALARA through the safe handling, storage, use, transport, and disposal of radioactive material. Further information and examples of acceptable work practices are available in the Radiation Safety Manual, the Basic Radiation Worker Training Handbook, the Radiation Safety Office Board on CC.Mail, or by contacting the Radiation Safety Services office at 424-7676.

I am committed to the success of our ALARA program. I ask that you join me in supporting this commitment in your use of radioactive materials by developing an understanding of applicable policies and procedures, complying with these requirements, and taking all practical measures to minimize radiation exposures to yourself and other staff members.

DEO/dpc

designated representative. This quorum is to include at least one member from each of the technical disciplines necessary to assess potential hazards and other criteria listed in the RSC Charter. The RSC meets at least semiannually (including an annual audit) to review findings of the RSO.

10.2 Radiological Safety Officer

The RSO reports to the CEO through the Environment, Safety and Health Department (ES&H). The RSO position is a full-time assignment, supported by a staff of four radiation protection technicians. The RSO's responsibilities include the following explicit functions:

10.2.1 Assuring the coordination of requests for radioactive material uses (RMA's), with requirements for RSC reviews.

10.2.2 Overseeing all activities involving radioactive material, including the oversight of routine monitoring and surveillance of all areas in which radioactive materials are used. The RSO also arranges for periodic surveys of work areas to supplement and audit routine monitoring by authorized users. The radiation protection technicians, under the direction of the RSO, conduct routine (at least annual) surveys and audits of all laboratories that utilize radioactive materials. These surveys supplement the routine monitoring by authorized users.

10.2.3 The RSO determines compliance with rules and regulations, license conditions and conditions of RSC approval of research programs.

10.2 The RSO oversees the Radiation Safety Services program associated with receipt and shipment of materials.

10.2.5 The program under the RSO is also responsible for maintaining an inventory of all radionuclides and limiting the quantities of radionuclides to the amounts authorized by the license.

10.2.6 Oversight of the radioactive waste disposal program, including waste storage and disposal records, as well as the monitoring of effluents.

10.2.7 Oversight of the storage of all radioactive materials not in current use, including wastes.

10.2.8 Oversight of the distribution of personnel monitoring devices and arrangement for their processing, determining the need for and evaluating bioassays, keeping records of personnel exposures and bioassays, notifying individuals and their supervisors of exposures that are approaching maximum permissible amounts, and recommending and supervising appropriate remedial action.

10.2.9 Arranging for calibration of instruments associated with the Radiation Safety Services program.

10.2.10 Arranging for the performance of leak tests on sealed sources.

10.2.11 Oversight of the Radiation Safety Training Program; assuring appropriate instruction is provided commensurate with exposure potential to personnel.

10.2.12 Furnishing consulting services regarding radiation safety to personnel at all levels of responsibility.

10.2.13 Oversight of the monitoring of the maintenance of special filter systems associated with the use, storage, or disposal of radioactive material.

10.2.14 Supervising and\or overseeing decontamination in case of contaminating accidents.

10.2.15 Maintaining other records not specifically designated above; including records of surveys, radiation monitoring, receipts, transfers, and surveys.

10.2.16 The SH&ES Manager acts as the Retired Facility Site Representative for the Retired Battelle Research Reactor (BRR). The responsibilities associated with this position include the review of surveys on a quarterly basis and preparation of the annual report to NMSS.

10.2.17 The RSO delegates the authority for day-to-day operational control of BCLDP radiological operations to the SH&ES Manager. The BCLDP shall follow the program outlined in the Decommissioning Plan, including the use of RWPs to manage exposures to radioactive material under their control.

10.3 Administrative Procedures

10.3.1 Control of Procurement and Use

Administrative procedures are in place to assure control of procurement, use, storage, and disposal of radioactive materials. Detailed procedures associated with this subject are provided in the BCO Radiation Safety Manual, Appendix C of this application, and as stated in the following sections. Radioactive material use for BCLDP operations is conducted pursuant to a Radiation Work Permit (RWP). The RWP is discussed in detail in the Radiation Protection Program for the BCLDP, Appendix D. Typical BCLDP radioactive material uses are associated with the decontamination aspects of removal of the material from building surfaces.

10.3.1.1 Material Accountability Program

All radioisotope procurement and possession are controlled to assure compliance with the Battelle license and NRC regulations. All radioactive material introduced into the BCO and BCLDP programs, regardless of activity or means of production, must be authorized for possession by an approved Radioactive Materials Application (RMA). This includes quantities normally considered exempt under NRC regulations. The BCLDP D&D program uses the RMA process for their limited purchases of radioactive material; e.g., small instrument calibration sources. The BCLDP controls the possession and removal of residual materials by use of RWPs.

10.3.1.2 Radioactive Material Applications (RMA's)

An approved Radioactive Material Application (RMA) is required prior to the procurement of radioactive material

and/or the commencement of any new work involving exposure to ionizing radiation from licensed materials in BCO operations. All personnel subject to exposure to ionizing radiation from licensed material are listed on the project's RMA. Personnel must complete the training requirements outlined in the BCO Radiation Safety Manual prior to initial exposure. Line management reviews and approves proposed radiological projects for submission to the RSO through the RMA process. They provide the managerial oversight and review necessary to ensure consistent application within their Divisions of the radiological controls required by the Radiation Safety Manual and other radiological controls implemented by the RSO. A copy of a BCO RMA is provided as Attachment I and a BCLDP RWP is provided as Attachment II in Appendix F.

10.3.1.3 Receipt and Shipment of Materials

All packages of radioactive materials received at Battelle are surveyed by Radiation Safety Services to ensure that the applicable requirements of 10 CFR Part 20 are met. The materials are tracked by RMA number and logged into Radiation Safety Services inventory. After survey results are verified, RMA source custodians are notified for pick-up of packages. Sealed sources for the BCLDP are authorized under the RMA process and tracked by the BCLDP source custodian as described in the BCLDP Decommissioning Plan.

All packages of radioactive materials shipped from Battelle are checked by Radiation Safety Services to ensure compliance with applicable international, federal, and State of Ohio requirements. Prior to shipping material, Radiation Safety Services verifies recipients' authorization to receive radioactive material.

10.3.1.4 Radioactive Materials Inventory

RMA source custodians are responsible for the day-to-day maintenance of their group's accountability logs. Source custodians are required to report inventory to Radiation Safety Services on a quarterly basis. Radiation Safety Services compares reported inventories to active RMA's to ensure compliance with allowable limits.

10.3.2 Quality Assurance and Control

Quality assurance programs are incorporated to ensure the accountability and effectiveness of the radiation protection programs for both BCO and BCLDP operations. The programs are described in various Battelle documents such as: Quality Assurance Manual, Decontamination and Decommissioning Operations; BCO ES&H Radiation Safety QA Plan; and Quality Administrative Procedures, Decontamination and Decommissioning Operations. These programs include guidance on record requirements, and required quality control. Annual reviews and appraisals of operations are performed by the Radiological Safety Committee. Independent programmatic and activity assessments of BCLDP operations are performed by Quality. Appraisals of BCO operations by the Radiological Safety Officer are conducted at sufficient frequencies to ensure that exposures to licensed materials are maintained ALARA. These appraisals are performed to ensure that the radiological safety practices of the Radiation Safety Services staff and authorized researchers comply with applicable regulations, guidelines, and accepted practice. On an annual basis, Radiation Safety Services also performs a review of each active RMA to ensure all information is accurate. In addition to RMA reviews, Radiation Safety Services routinely reviews laboratory procedures and record keeping during monthly surveys as prescribed in the BCO Radiation Safety Manual (Appendix C). In addition, a Regulatory Compliance and Oversight Program performs appraisals and surveillances of all BCLDP activities.

10.3.3 Safety Evaluations of Proposed Uses

10.3.3.1 Evaluations are performed on proposed uses of all radioactive materials. Mandatory criteria for review is stated in the RSC Charter.

Key evaluation criteria are the training and experience of supervisors and end users. Appendix A contains biographical information for key personnel associated with use of radioactive materials.

10.3.3.2 Evaluations are also performed with regard to the facilities and equipment associated with each specific use including:

- Shielding
- Containment
- Restricted area controls and postings
- Remote handling equipment
- Survey and monitoring instruments
- Material control, accountability and record keeping.

10.4 Personnel Monitoring

10.4.1 Licensed Material and Exposure Controls

While the Radiological Safety Committee and Radiological Safety Officer are jointly responsible for maintaining overall personnel ionizing radiation exposures ALARA by providing adequate controls for licensed materials used at Battelle, each authorized user is responsible for maintaining their personal exposure ALARA. The Radiological Safety Officer is authorized to conduct such programs and operations as are required for routine maintenance of campus-wide control of licensed materials used at Battelle.

The BCLDP operates a comprehensive and formalized ALARA program specifically dedicated to the D&D program.

10.4.1.1 Occupational Radiation Exposure Control Program

Dosimetry Services obtains a record of the occupational dose history of each person granted routine access to restricted areas prior to the granting of routine access. This dose record is evaluated to ensure that the person may receive occupational exposure to ionizing radiation within the applicable requirements of 10 CFR Part 20.

A permanent personnel monitoring file is then established and maintained for each staff member subject to exposure to ionizing radiation from licensed activities. Each file contains current NRC Forms 4 and 5 or equivalent, verified copies of the documents from which the information on the forms was drawn, and any other information deemed relevant to the person's exposure history by Radiation Safety Services and/or Dosimetry Services.

All radiation dose, exposure, and bioassay reports for licensed activities at Battelle are recorded, reviewed and filed by Dosimetry Services. Exposure reports are issued annually to each individual.

10.4.1.2 Occupational Dose Action Levels

Occupational dose action levels are currently established at ten percent (10%) of the applicable dose limits in 10 CFR Part 20. Exceptions to the action levels may be granted by the RSO or RSC if engineering and process controls cannot reasonably be used to maintain exposures below the action levels. The greatest potential for exposures in excess of the action levels will occur during the decommissioning of the Hot Laboratory facilities at the West Jefferson site.

10.4.1.3 External Exposure Control Program

All persons who are likely to receive an annual occupational radiation exposure of 100 millirems effective dose equivalent are provided personnel dosimetry (contracted with a vendor) appropriate to the external ionizing radiation exposure hazards resulting from licensed activities at Battelle. The dosimetry for Battelle has been chosen to be appropriate for the detection and determination of the types, energy ranges, and dose ranges of the ionizing radiations to which the person will be exposed.

All issued dosimetry devices are collected at regular intervals (quarterly or monthly) and forwarded to a dosimetry processor meeting the requirements of 10 CFR Part 20 and National Voluntary Laboratory Accreditation Program (NVLAP) criteria for relevant exposure assessments. Recorded exposures in excess of the action levels are immediately reported to the Radiological Safety Officer so that appropriate action can be taken to determine the cause of the increased dose and minimize further exposures. The external dosimetry program is reviewed on a regular basis to ensure compliance with regulatory guidelines and accepted practice.

10.4.1.4 Internal Exposure Control Program/Bioassays

For the BCLDP, the primary method for monitoring of workers and assigning internal exposure is air monitoring. Where bioassay monitoring is conducted with air monitoring, or in the absence of air monitoring, the scope and periodicity of monitoring shall be based on evaluation of the worker's assignments, exposure potential, and good health physics practices.

For the BCLDP, routine bioassay monitoring shall be required where air monitoring for the specific purpose of establishing internal exposure cannot effectively be accomplished. Personnel working with radioactive

materials in quantities and forms which could produce 100 mRem of committed effective dose equivalent annually when taken into the body through inhalation, ingestion or absorption shall be evaluated to determine what program is appropriate for their work assignment and exposure potential which may include entry (baseline) and exit or annual bioassay monitoring for the dominate radiation type or species under consideration. Routine bioassay monitoring for persons not covered under an air monitoring program for the specific radioactive material with which they are authorized to work shall be monitored on a frequency established in Table 10.4-1, "Routine Bioassay Monitoring Frequency."

Bioassay monitoring results may be used to test the effectiveness of the air monitoring program where such exist. Positive analytical results shall be compared against exposure assigned as result of DAC hours, per US NRC Regulatory Guide 8.25, Revision 1, "Air Sampling in the Workplace."

Where routine bioassay monitoring is required due to the absence of an air monitoring program, bioassay results shall be used to assign internal dose. Action levels for results used for this purpose shall be established at 500 mrem committed effective dose equivalent per isotope or combination of isotopes. If minimum detectable for a specific isotope level would exceed this value then collection frequency shall be increased and/or other technically acceptable means shall be used to increase sensitivity to a level which would be $\leq$ 500 mrem.

Battelle Columbus Laboratories Decommissioning Project (BCLDP), which has greater potential for internal exposure, has developed an Internal Dosimetry Technical Basis Document, (DD-93-09) for establishing implementation of the above described program.

For the BCO program, i.e., non-BCLDP covered personnel, evaluation of the need for monitoring is performed at the time of authorizing radioactive material users through the Radioactive Material Application (RMA) system. This evaluation includes, but is not limited to, worker's assignments, exposure potential, and good health physics practices. This evaluation may also include the use of guidance of Regulatory Guide 8.25 Revision 1 for evaluation of the potential to exceed 10 percent of the ALI. Modification to the experimental protocol are included as a means of exposure minimization. Any individuals meeting the greater than 10 percent of ALI are placed on a routine bioassay program or monitored under an air sampling monitoring program, or some combination of both. This will be identified on the RMA or RWP.

Table 10.4-1 Routine Bioassay Monitoring Frequency

FREQUENCY	TYPE OF SAMPLE	ISOTOPES
Monthly	Urine	H-3, S-35, I-125, I-131, Sr-90, U Class D & W for U-235 < 10%
Quarterly	Urine	Pu-238, Pu-239
Semi-Annually	Urine	U Class D & W for U-235 > 10%, MFP, Th-(Nat)
	In-vivo	Cs-134, Cs-137, Co-60
Annual	Urine	U Class Y

10.5 Surveillance Program

Radiation and contamination surveys are conducted routinely to ensure that radiation fields and contamination levels in accessible areas are sufficiently characterized that personnel doses are maintained ALARA. They are reviewed

on a routine basis to ensure the timely identification of changes in the facility radiation and contamination patterns sufficient to cause personnel exposures approaching the Battelle action levels.

10.5.1 Working Atmosphere Monitoring & Control

Periodic air samples are taken in worker's breathing zone for all operations where the airborne radionuclide concentrations may be reasonably expected to exceed ten percent (10 %) of the applicable limits in 10 CFR Part 20 Appendix B, Table 1, Column 3.

Areas where the known or suspected airborne radionuclide concentrations are ten percent (10 %) or more of the applicable limits in 10 CFR 20 Appendix B, Table 1, Column 3, are posted as Airborne Radioactivity Areas and access is restricted.

10.6 Material Release Program

Items used in restricted areas are not released for unrestricted use until they have been verified by Radiation Safety Services to meet the established release criteria. All items to be released for unrestricted use must meet the limits of "Guidelines for Decontamination of Facilities and Equipment Prior to release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" U S. Nuclear Regulatory Commission April 1993. Survey records for all items released for unrestricted use will be maintained by Battelle for a period not less than ten (10) years from the end of licensed activities. Releases from the BCLDP are governed by the Decommissioning Plan and supporting procedures.

10.7 Airborne Radioactivity Control

Appropriate enclosures and filtered ventilation systems are used to ensure the containment of airborne radioactive materials and prevent their unmonitored release to the environment. Work with unsealed radioactive materials is performed within the confines of an approved hood or glove box when required as a condition of an approved RMA, and whenever possible even though not a condition of an approved RMA. If the calculated average concentration exceeds 10% of the applicable limit, breathing zone and/or general area air samples will be collected with calibrated air sampling systems using an appropriate trapping solution and/or collection filters.

Appropriate containment systems are incorporated in all BCLDP operations where airborne radioactivity control is required.

10.8 Liquid Effluent Control

Battelle does not dispose of licensed material in the sanitary sewer system in concentrations exceeding the applicable limits of Appendix B, Table 3 of 10 CFR Part 20 (20.1001 - 20.2401). Appropriate records containing activity and concentration are maintained for any sewer releases. In addition, Radiation Safety Services must grant prior approval to any laboratories prior to commencing any sewer releases. The BCLDP program uses Release Permits to address this control function according to the Decommissioning Plan and supporting procedures.

10.9 Alert and Action Levels

Alert and action levels for surface contamination, airborne radioactivity, and liquid effluents shall be provided and used for all license related activities as specifically incorporated in the BCO and BCLDP control documents.

10.10 Leak Testing Sealed Sources

The radiation protection program includes compliance with the NRC standard for periodic leak testing of all sealed sources. This function is performed by Radiation Safety Services and BCLDP Health Physics personnel.

10.11 Respiratory Protection Program

Process and engineering controls shall be the primary method used by BCO to ensure that exposures to concentrations of licensed materials exceeding the limits outlined in 10 CFR Part 20 do not occur. A Respiratory Protection Program shall be implemented to provide personnel protection in those cases where engineering or process controls are impractical. The program shall meet the requirements contained in 10 CFR Part 20, ANSI Z88.2, and 29 CFR 1910.134 for implementation of a Respiratory Protection Program and associated training of personnel. Since the BCLDP is a Decontamination and Decommissioning project, it is often very difficult or not cost effective to construct process and/or engineering controls due to the limited work duration, non-uniform contamination distribution, limit area access and support service

access, etc. Respiratory protection is often the only practical solution. An extensive respiratory protection program is an integral component of the BCLDP D&D Program.

10.11.1 Respirators shall be issued only to personnel who are trained, fitted and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually.

10.11.2 Engineering controls shall be designed to control radioactive materials at the source, so that respiratory protection requirements are minimized.

10.12 Training

All persons authorized to work with radioactive materials are provided instruction in radiation safety commensurate with the radiological hazards they are likely to encounter. Personnel requiring access to Department of Energy regulated facilities under the control of the BCLDP also receive training in accordance with NRC and DOE requirements prior to authorization of initial access to those areas.

10.12.1 As a minimum, the training program covers potential risks of radiation exposure, the ALARA concept, the Radiation Protection Plan and/or the Radiation Safety Manual, ionizing radiation sources, postings, and safe practices.

10.12.2 The program includes appropriate testing of each trainee to ensure satisfactory completion of the formal training sessions and requires annual retraining.

10.13 Environmental Monitoring

A formalized environmental monitoring program is in place for the BCLDP. Battelle will continue to provide the Annual Battelle Environmental Monitoring Report to both the Region III Office and to NRC Headquarters when released for distribution by the DOE. Research activities associated with the use of radioactive materials in BCO operations do not require specific environmental monitoring considerations at this time, based on 10 CFR Part 20, Appendix B values and 40 CFR Part 61 requirements.

10.14 Emergency Procedures

Emergency management response is described in two master documents: "Emergency Plan, West Jefferson" issued in January, 1990 and the "Emergency Plan, Columbus Campus" issued in December 1993. These two plans provide a framework and establish a uniform approach for managing BCO emergency resources with off-site emergency response agencies. The individual research divisions develop their own specific procedures to operate within the overall BCO framework.

Although continued R&D requires the use of radioactive materials at both the King Avenue and the West Jefferson sites, the majority of the radioactive material inventory is controlled through the Battelle Columbus Laboratory Decommissioning Project (BCLDP). As a result, the BCLDP has developed and implemented the "BCLDP Emergency Management Plan, DD-93-07" dated February 24, 1993. This document is a comprehensive emergency management plan for activities conducted by the Battelle Columbus Laboratories Decommissioning Project. This emergency management plan applies only to the facilities under the control of BCLDP at the King Avenue and the West Jefferson North sites. It is administered and implemented by a series of procedures that describe in detail: (1) the responsibilities required to maintain the program; (2) the physical actions to be taken by emergency responders in order to assess and mitigate incidents which may pose hazards to life, health or property, and; (3) the means by which the BCLDP Emergency Management Organization (EMO) facilitates notification of local, state and federal government agencies in compliance with all applicable regulations.

The BCLDP Emergency Management Plan does not decrease the emergency response effectiveness that was represented in the "Radiological Contingency Plan (RCP) for Battelle's Columbus Laboratories" issued January 1982, but has been updated, in compliance with Title 10, Code of Federal Regulations, Part 70.22(i), to reflect changes in potential hazards represented by current and projected BCLDP activities. It was developed to work as a compatible, complementary, constituent to BCO's "Emergency Plan, West Jefferson" issued in January 1990 and "Emergency Plan, Columbus Campus" issued in December 1993.

The BCLDP Emergency Management Plan, DD-93-07 supersedes the "Emergency Plans and Procedures - West Jefferson North, Decontamination and Decommissioning Operations" issued March, 1990 and the "Radiological Contingency Plan (RCP) for Battelle's Columbus Laboratories.

DD-93-07 was prepared using NRC Regulatory Guide 3.67, "Standard Format and Content For Emergency Plans For Fuel Cycle and Materials Facilities" and NUREG 0654, FEMA-REP-1, Revision 1 "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" as primary developmental resources.

11.0 WASTE MANAGEMENT

11.1 BCO Waste Management Operations

All radioactive waste generated by individual RMA holders is collected within the user areas in approved waste containers in accordance with procedures specified by Radiation Safety Services in accordance with the BCO Radiation Safety Plan (Appendix C). The personnel who pick-up the radioactive waste are trained by Radiation Safety Services. These individuals are hazardous waste technicians in the Hazardous Materials Section of the BCO Environment, Safety, and Health Department and are trained to properly handle and package all hazardous chemical and low-level radioactive waste. The radioactive waste is not removed from the user's area unless the user has packaged and labeled the radioactive waste in accordance with Radiation Safety Services instructions.

Short half-life radioisotopes, i.e., half-life of less than 100 days, may be stored for decay prior to disposal as uncontrolled waste. All such waste will be stored for a minimum of 10 half-lives and shall also be surveyed prior to disposal to ensure no detectable activity above applicable release limits remains.

11.2 BCLDP Waste Management Operations

In addition to the BCO waste management program, the BCLDP operates a separate comprehensive waste management program to handle all radioactive waste generated as a direct result of decontamination operations associated with this DOE-related program. All radioactive waste generated by the program is collected, segregated, characterized, and packaged in accordance with strict procedural requirements responsive to DOE approved disposal site criteria.

BCLDP personnel who process the radioactive waste are trained by the use of waste management plans and procedures. These individuals are trained to properly handle, package, and ship low-level radioactive waste. All radioactive waste generated by the BCLDP is, by contract, DOE's waste.

12.0 LICENSE FEES

As indicated in the cover letter we are enclosing a check in the amount of $2200.00 for full payment as required by paragraph 170.12(a) of 10 CFR Part 170.

13.0 CERTIFICATION

The application has been signed by Gregory Fess, Battelle's NRC License Coordinator, authorized to sign NRC submittals and certify that this application is true and correct to the best of his knowledge and belief.

APPENDIX A

BIOGRAPHICAL INFORMATION

Education

B.S., Chemical Engineering, Massachusetts Institute of Technology, 1956
Ph.D., Physics, The Ohio State University, 1972

Qualifications

Dr. Barnes has conducted many research programs related to optics and spectroscopy. Many of these programs have involved the use of optics as a diagnostic tool to gain information on combustion systems, surface chemistry, and gas phase kinetics.

Relevant Experience

Laser Spectroscopy Applications. Development of laser-fluorescence techniques to measure chemical free radicals, NO and NO_2 in flames. Laser-Raman measurements of temperature and species in flames and combustion systems. Studies of gas-phase reactions of polymeric materials using laser spectroscopy. Development of laser fluorescence techniques to measure nitrous acid and polycyclic aromatic hydrocarbons in the atmosphere. Excited-state laser spectroscopy of diatomic molecules. Development of laser luminescence techniques for direct measurements of polycyclic aromatic hydrocarbons on fly ashes and particulates. Use of laser fluorescence to measure free radicals and small pollutant molecules in powdered coal flames.

Laser-light Scattering for Measuring Droplets and Small Particles. Measurements of droplet size in fuel-oil sprays. Measurement of water droplets in a steam-tube rupture experiment. Measurement of particles in diesel engine exhausts.

Optical and Spectroscopic Instrumentation for Process Control Applications. Development and in-plant testing of instrumentation with microprocessor system for on-line monitoring of organic gases in chemical plant process streams. Development of SO_2 monitors for stacks. Assembled and tested fluorescence instrumentation for on-line monitoring of polycyclic aromatic hydrocarbons in exhaust gases from incinerator systems. Performed studies to develop basis for correlating spectral emissions from powdered coal flames with fuel/air stoichiometry. Developed CO monitor for continuous process control applications. Development and testing of monitor based on use of derivatized fluorescence for the detection of chemical warfare agents.

Professional Recognition and Affiliations

Dr. Barnes also served as Research Associate in the Department of Physics at The Ohio State University while completing his Ph.D. dissertation in molecular physics and spectroscopy. His studies there involved the high-resolution infrared spectroscopy of the acetylene molecule involving the isotopic species carbon-13 and dueterium. He is a member of the Optical Society of America, Sigma Xi, and Sigma Pi Sigma, the Physics Honorary Society.

Radiological Safety Officer

Education

M.S., Environmental Engineering, Concentration in Radiological Health Physics, University of Florida, 1988
B.S., Computer Science, Florida International University, 1984
A.A., General Sciences, University of Florida, 1981
Radiological Safety Officer Training, Technical Management Services, Orlando, Florida, 1993
Basic Radioactive Waste Workshop, Aiken, South Carolina, 1993
29 CFR 1910.120 OSHA Hazardous Waste Operations and Emergency Response Training, 1990-93

Qualifications

Mr. Clum has over eight years of professional experience in Radiological Health Physics. His experience includes work at research laboratories, nuclear power plants, and an environmental remediation site.

Relevant Experience

Mr. Clum joined the Battelle staff in August, 1992, as the Radiological Safety Officer with the Environment Safety and Health Department and as a member of the Radiological Safety Committee. As Radiological Safety Officer, he manages the radiation safety program and is responsible for the development and implementation of policies and procedures for the safe handling, storage, use, transport, and disposal of radioactive material. He is responsible for advising and training staff with regard to the safe performance of radiological operations. He reviews and approves projects which handle radioactive material or utilize equipment that emit ionizing radiation and conducts oversight activites to assist in compliance with approriate state and federal regulations .

Before joining Battelle, Mr. Clum was a health physicist at The Weldon Spring Site Remediation project, from 1990 to 1992. During that time he provided design review and field oversight for remedial action and demolition projects. He also performed atmospheric dispersion modeling and off-site dose assessment, radiological emergency scenario development and planning, development and implementation of health physics procedures, and development of annual site environmental reports and monitoring plans.

Dennis P. Clum (Continued)

Mr. Clum was a health physicist from 1987 to 1990 at Catawba and Oconee Nuclear Power Stations. His work experience included contamination control, emergency planning and response exercises, radiological dose assessment, and operational health physics.

Mr. Clum was an environmental health physicist and supervisor of the gamma spectroscopy laboratory at the University of Florida from 1985-1987. His responsibilities included operation and calibration of radiological instrumentation, environmental monitoring and interpretation of analytical results.

Professional Affiliations

Mr. Clum is an active member in the Health Physics Society and the American Nuclear Society. Mr. Clum is pursuing certification with the American Board of Health Physics.

Senior Research Leader
Energy Systems Group

Education

B.E., Engineering Physics, Cornell University, 1963
M.S.E., Nuclear Engineering, University of Florida, 1965
Ph.D., Nuclear Engineering, University of Florida, 1967

Qualifications

Dr. Denning has directed and performed research related to the safety and risk of nuclear facilities and nuclear power reactors for over 24 years. He directed Battelle's participation in the Reactor Safety Study, the first major effort to describe the risk to the public from nuclear plants. Dr. Denning subsequently managed a number of programs for the NRC involved with the development and application of codes for the assessment of severe accidents. He has also performed studies to develop methods for the use of risk analysis results for regulatory decision making and research prioritization.
Dr. Denning was a major contributor and lead author on two chapters of the NRC's evaluation of the technical basis for severe accident source terms, NUREG-0772. He has been a reviewer and provided technical support to the NRC's reassessment of accident source terms, NUREG-0956, and managed a task to provide source term analyses for NUREG-1150, an evaluation of reactor risk for five reference plants. He authored a chapter of the PRA Procedures Guide, NUREG/CR-2300. He was appointed to a National Research Council Committee to review the safety of DOE reactors. He also attended the IAEA Vienna Conference on Chernobyl as a U. S. delegate. He was a member of DOE's Advisory Committee on Nuclear Facility Safety, 1987-1990.

Relevant Experience

New Production Reactor (NPR). Dr. Denning currently has responsibility for Environment, Safety and Health for the Heavy Water Reactor Facility. Two levels of internal safety assessment are being performed under his direction: a detailed review which primarily assures conformance with detailed review plans, DOE Orders and NPR Requirements, and a higher level review performed by the Independent Safety Review Team. The Integrated Safety Analysis Report and required environmental permit applications will be prepared under his supervision

Reactor Risk Studies. In support of the NRC's reexamination of the risk of light water reactors (NUREG-1150), Dr. Denning managed the analysis of source terms for the five reference plants. He also authored two of the chapters in the report. He participated as a technical expert in the areas of fission product behavior, severe accident loads and containment performance for the NUREG-1150 uncertainty analysis. Earlier, Dr. Denning coordinated Battelle's efforts in WASH-1400, the first comprehensive examination of nuclear power plant risk.

Source Term Reassessment. Dr. Denning has been a major contributor to the NRC's reassessment of severe accident source terms. He performed analyses of physical processes of severe accidents in support of the two definitive NRC studies, NUREG-0772 and NUREG-0956. The Source Term Code Package, which was developed at Battelle, is the basis for the NRC's recommended treatment of source terms.

Severe Accident Research. Dr. Denning managed a task to assist the NRC in the evaluation and redirection of severe accident research. Dr. Denning managed the development of the severe accident code, MARCH. He supported the NRC's Special Inquiry Group examination of the TMI-2 accident.

Safety and Risk Studies for Portsmouth Gaseous Diffusion Plant. Dr. Denning managed programs on accident analysis and risk assessment for the gaseous diffusion plants (GDP), which are government-owned reactor fuel enriching operations. The study produced an evaluation of the health effects of fluoride (UF_6 and HF) releases, a risk analysis for the HF Tank Farm, and an accident analysis with estimates of residual risk for an upgraded HF Tank Farm at the Portsmouth GDP. The study also performed an accident analysis for the Decontamination and Recovery Facility and criticality analysis for the high assay sections of the cascade operations at Piketon.

Safety Analysis for Paducah Gaseous Diffusion Plant. Dr. Denning directed analyses on the safety of the existing HF, F_2, and acid handling systems at PGDP. Final report on this project was used as Section 5 of the FSAR for the facility, according to the guidelines of DOE/OR 5481.1.

Accident Thermal-Hydraulic Behavior. In a program to develop the TRAP code for the NRC, was responsible for describing thermal-hydraulic boundary conditions for the analysis of radionuclide transport and also provided general technical guidance to the project. Served as a principal author of NUREG-0772, Technical Bases for Estimating Fission Product Behavior During Light Water Reactor Accidents.

Alternative Reactor Concepts. Dr. Denning was a task leader on a major program performed for NSF to evaluate the potential advantages of a number of reactor concepts as alternatives to the liquid metal fast breeder reactor, light water breeder reactor, gas-cooled fast reactor, and high temperature gas-cooled reactor. Each concept was evaluated on the bases of economics, safety, environmental impact, safeguards, and development needs or hurdles.

Nitride Fuels Development. In the nitride fuels development program at Battelle, Dr. Denning performed kinetics analyses for a planned series of tests in the TREAT facility which was intended to investigate the response of these fuels to rapid power transients. Nitride fuels are leading contenders for use in space nuclear power systems and small reactors for remote applications.

Industrial Applications of Laser Fusion Energy. Acted as deputy program manager in an examination of the potential for applying Laser Fusion Reactors to industrial process heat applications.

Fusion Power Development Issues. Was principal investigator on an NSF study to evaluate alternative development strategies for commercial fusion power with particular emphasis on the relationship between fusion power development and fission breeder development.

Evaluation of ECC Behavior for the MHIA Reactor. Managed a program in which Battelle evaluated the ability of upgraded ECC systems in the MHIA Reactor to satisfy NRC regulations.

Probabilistic Risk Assessment. Under subcontract to Battelle's Pacific Northwest Laboratories, managed a program to develop methods of including the results of risk analyses in the regulatory process. The treatment of the large uncertainty bands associated with risk estimates and the use of

risk analysis to show compliance with safety goals have been considered in the program. Dr. Denning is a principal author of the report "PRA Procedures Guide" NUREG-CR-2300.

Risk of Disposal of High Level Radioactive Waste in Space. Performed a comparative evaluation of the comparative risks of terrestrial and space disposal of high level waste from nuclear power plants.

Reactor Kinetics Studies. Dr. Denning wrote the two-dimensional, multi-group, space-time kinetics code ADEP which is available from the Argonne Code Center. He has used this code to explore the accuracy of point kinetics approximations and few-group collapsing techniques for the description of the rod-ejection accident in a pressurized water reactor and rod drop-out accident in a boiling water reactor.

Shielding Design of the Rocky Flats Plutonium Recovery Facility. Under subcontract to the architect-engineer, Dr. Denning developed methods of analysis for shielding plutonium handling operations. He then provided technical consultation and review of the shielding design effort.

Professional Recognition and Affiliations

Member, American Nuclear Society, Sigma Xi; Registered Professional Engineer in the State of Ohio (No. 39072); Chairman of the Nuclear Safety Subcommittee of Battelle's Radiological Safety Committee; Chairman of Battelle's Dosimetry and Accident Evaluation Unit at Battelle. Holds active DOE Q and DoD Secret clearances.

Gregory Fess

NRC Licensing Coordinator

Education

J.D., Georgetown University Law Center (1971) (Law)
B.A., Miami University, Oxford, Ohio (1967) (Political Science)

Qualifications

Mr. Fess is currently Corporate Counsel for Environmental and Regulatory Compliance. Serves as chief legal advisor for assuring compliance with environmental, safety, and health standards, including requirements arising from DOE, NRC, EPA, OSHA, RCRA, CERCLA, and Clean Water and Air Acts. Has been designated by the CEO as the NRC Licensing Coordinator, responsible for all matters relating to activities under the NRC license.

Relevant Experience

Environment, Safety and Health (ES&H) Matters. Special Assistant U.S. Attorney in charge of representing the United States in the enforcement of ES&H statutes and their implementing regulations.

Prior Professional Experience

U.S. Department of Energy, Rocky Flats Plant, Chief Counsel (1990-1991). Represented DOE and the Rocky Flats Office in all legal matters concerning environmental compliance and waste management. Negotiated the Rocky Flats Interagency Agreement for CERCLA, RCRA, and NEPA compliance. Negotiated settlement agreements in various federal court cases involving environmental compliance issues.

Special Assistant U.S. Attorney, Office of the United States Attorney, Northern District of Ohio (1989). Responsible for conducting major federal court litigation and negotiations on behalf of the U.S. Environmental Protection Agency (EPA) and its regional offices.

Senior Counsel, Special Litigation, Office of the General Counsel, United States Department of Energy, Washington, D.C. (1981-88). Supervising counsel responsible for the management of ES&H matters involving DOE and its contractors.

Special Counsel, Assistant General Counsel for Environment, United States Department of Energy (1980). Special detail from policy office to General Counsel to develop legal strategy respective to the Department's licensing reform legislation for radioactive waste management and spent fuel programs for submittal to the 97th Congress.

Director of Environmental and Regulatory Policy, Office of Nuclear Policy, United States Department of Energy (1978-79). Senior policy analyst responsible for developing and coordinating major departmental analyses of environmental and regulatory aspects of the nuclear energy sector.

Attorney, Hearing Division, Office of the Executive Legal Director, Atomic Energy Commission/Nuclear Regulatory Commission (1974-78). Represented the commission in licensing hearings for nuclear power plants, nuclear reprocessing plants, and radioactive waste and spent fuel storage facilities.

City Prosecutor, City of Toledo, Ohio (1974). Represented the city in the prosecution of various violations of city statutes.

Morrato, Gueck & Colantuono, P.C., Denver, Colorado (1971). Associated Member involved in general private practice.

Professional Recognition and Affiliations

Mr. Fess is admitted to practice before the Bars of the States of Ohio and Colorado, the U.S. Courts of Appeals for the Sixth and Tenth Circuits, and the U.S. Supreme Court. He is a member of the Ohio Bar Association, Environmental Law Committee; the Columbus Bar Association; and the American Corporate Counsel Association.

George E. Kirsch RSC Member

Senior Health Physicist
Radiological Technical Support Group

Education

B.S., Engineering Technology, Franklin University
Basic Radiological Health, U.S. Public Health Service; Atomic Energy Commission Fire School; In-Place Filter Testing, Harvard School of Public Health; Respiratory Protection, Los Alamos Scientific Laboratory; Applied Health Physics, Oak Ridge Associated Universities; Internal Dosimetry for Fixed Nuclear Facilities, Oak Ridge Associated Universities; the Ohio State University Continuing Education Program "Radionuclides in the Biosphere", and forty-hour HAZWOPER training presented at Battelle.

Qualifications

Mr. Kirsch is a registered radiation protection technologist with involvement in a wide spectrum of safety areas, with major emphasis for the past 20 years in health physics. As a former supervisor of the Health Physics Group, Mr. Kirsch was involved with radiological safety considerations at the Battelle Columbus Division, including the Hot Cell Facility. His responsibilities also included administering the personnel dosimetry, bioassay, radiation safety training, respiratory protection, and in-place filter testing programs. He was also involved in the design and implementation of radiological safety programs associated with the characterization, decontamination and decommissioning of sponsors' facilities at offsite locations. Mr. Kirsch was an alternate coordinator for the Emergency Control Group and an advisor to the Radiological Control Group for the Battelle Nuclear Sciences Area. In addition, Mr. Kirsch was an official member of a U.S. Department of Energy (DOE) Radiological Assistance Team and has participated in a number of mobilization activities associated with requests for emergency assistance. Mr. Kirsch has also served as a member of the State of Ohio Governor's Technical Advisory Group for Radiological Emergencies at Fixed Nuclear Facilities and is a member of the Battelle Radiological Safety Committee. Recently Mr. Kirsch was involved in the implementation the Radiation Protection Oversight Program associated with the Battelle Columbus Laboratories Decommissioning Project. Currently Mr. Kirsch is a senior health physicist with the Radiological Technical Support Group associated with the decommissioning project, as the Procedures and Compliance Coordinator.

Relevant Experience at Battelle

- Decontamination and Decommissioning of the Battelle Columbus Laboratories Plutonium Laboratory. As the former Supervisor of the Operational Health Physics Group, provided program direction for radiological safety services for personnel and facilities monitoring during this comprehensive program involving the dismantling of a major portion of the facility and associated equipment. Designed the personnel respiratory protection system utilized during the volume reduction of gloveboxes contaminated with plutonium. The volume reduction operations involved the actual cutting of gloveboxes and equipment into small pieces by operators suited in protective clothing and air-line respirators working in controlled atmosphere tents (1978 - 1982).

- Comprehensive Radiological Survey of a Department of Energy Storage Site. As the former Health Physics Supervisor, established the health physics program and protocols for personnel protection and site monitoring for a comprehensive radiological survey of a 190-acre site including buildings and grounds. The survey centered around the protection and monitoring considerations for both Battelle and subcontractor personnel. The radiological monitoring system was established in compliance with U.S. Department of Energy and U.S. Nuclear Regulatory Commission standards. The purpose of the health physics program was to locate the exposure source terms, consisting primarily of a significant inventory of both stored uranium/pitchblend residues and shallow waste burials. (1979)

- Radiological and Structural Examination Program for a Retired U.S. Department of Energy Demonstration Nuclear Power Facility. As Project Leader, performed annual radiological surveys of a retired demonstration nuclear power facility. Based on data generated by annual surveys, recommended changes and additions to the survey program to include structural integrity surveillance to detect possible shielding degradation an environmental soil sampling program of the grounds immediately surrounding the facility. (1975 - 1989).

- Verification of Radiological Surveys of Effectiveness of Decontamination Activities of a USDOE Facility. As Project Leader, established a monitoring program to verify successful decontamination activities of laboratory facilities undergoing decontamination. The survey parameters include measurements of fixed and transferrable actinide levels on various structural surfaces in strict conformance with quality assurance procedures (1980 - 1988).

  Also managed a program associated with the verification of decontamination effectiveness of soil in area external to the above laboratory facilities (1986).

In addition to these programs, Mr. Kirsch has participated as a health physicist responsible for the safety of Battelle staff performing environmental monitoring at other DOE sites; i.e., Pinnellas, Nevada Test Site. (1987 - 1988)

Professional Affiliations

Mr. Kirsch is a Registered Radiation Protection Technologist, member of the National Registry of Radiation Protection Technologists, and a plenary member of the Health Physics Society. He is also a charter member and has served as committee chair, executive council member, secretary, and president (1992-1993) of the Buckeye Chapter of the Health Physics Society.

Stephen J. Layendecker

BCLDP Safety, Health, and Environmental Support Manager

Education

M.S., Radiation Biology, University of Tennessee, Knoxville, Tennessee, 1981
B.S., Biology, Tusculum College, Greeneville, Tennessee, 1979
29 CFR 1910.120 OSHA Training for Operations on Hazardous Waste Site, IT Corporation, Knoxville, Tennessee, 1989
Operation of a Panasonic TLD Program, Phillip Plato, Inc., Fort Meyers, Florida, 1987
Environmental Radiation Surveillance, Harvard School of Public Health, Boston, Massachusetts, 1986
Internal Dose Assessment, Technical Management Services, Chicago, Illinois, 1984
As Low As Reasonable Achievable (ALARA) Training Course, General Dynamics, Electric Boat Division, Groton, Connecticut, 1981

Qualifications

Mr. Layendecker is a certified health physicist with more than 10 years professional experience in Health Physics-related fields. His experience includes work at U.S. Nuclear Regulatory Commission (NRC) licensed plants, material licensees, and U.S. Department of Energy (DOE) facilities.

Relevant Experience

Safety, Health, and Environmental Support. Safety, Health, and Environmental Support Manager. Manages the Radiological Field Operations, Radiological Technical Support, Industrial Hygiene/Safety, and Environmental Support groups.

Prior Professional Experience

Senior Health Physicist, Nuclear Sciences, IT Corporation, Knoxville, Tennessee. Preformed health physics consulting in the areas of applied health physics, as low as reasonably achievable (ALARA) evaluations and radiation protection procedures.

Served as the Manager of Health Physics and was responsible for initiation and implementation of a radiation protection program for over 1,000 workers for the MK-Ferguson of Oak Ridge Company and Rust Engineering Company, Oak Ridge Operations. Also served as the IT/MK-Ferguson/Rust Engineering Project Manager and coordinated IT resources on the project.

Staff Health Physicist, Tennessee Valley Authority, Radiological Control, Chattanooga, Tennessee. Provided technical direction and oversight to all Tennessee Valley Authority (TVA) nuclear facilities, provided direct, on-site, operational support to Sequoyah Nuclear Station from 1988 to 1989 refueling outage, provided on-site support at Watts Bar Nuclear Station for design reviews and plant modification, performed internal assessments and investigations at all facilities, and participated as a qualified member of the TVA emergency response team.

Supervisor, Health Physics Section, Tennessee Valley Authority Watts Bar Nuclear Plant, Spring City, Tennessee. Managed the activities of the ALARA site program and radiation protection group

and implemented a procedure system, an audit and assessment program, and an employee development program.

Radiological Engineer I, II, III, General Public Utilities Nuclear Three Mile Island Unit-2, Middletown, Pennsylvania. Implemented exposure management activities, conducted audits of the Radiological Controls Program, initiated and reviewed procedures, ensured compliance with regulatory requirements, performed internal/external dose assessments, and performed ALARA reviews of work activities.

Professional Recognition and Affiliations

Mr. Layendecker has been published in *Experimental Hematology, Vol. 10, No. 4, April 1982*, "The Relative Roles of the Spleen and Bone Marrow in Platelet Production in Mice".

Mr. Layendecker is a Certified Health Physicist (Comprehensive) as recognized by the American Board of Health Physics and is a member of the Health Physics Society. He is also a certified lead auditor in accordance with ANSI/ASME NQA-1.

Jeffrey L. Means — RSC Chairman

Manager, Environmental Technology Department

Education

B.S., Geology, Bucknell University, 1974
M.A., Geology, Princeton University, 1976
Ph.D., Geochemistry, Princeton University, 1981

Qualifications

Dr. Means has participated in a wide range of chemical and geochemical research studies, and his primary interests are in the area of aqueous and soils geochemistry and waste treatment and disposal. Dr. Means has been studying the stabilization and solidification of metal-contaminated soils, with emphasis on the chemical mechanisms of hazardous waste stabilization. Dr. Means is also the Principal Investigator of several studies to recycle hazardous waste aggregates, such as spent sandblasting grit, into asphalt or Portland cement. Dr. Means is currently Program Manager of the Research, Engineering Assessment, and Control Technology Services (REACTS) task order contract with the U.S. EPA Risk Reduction Engineering Laboratory in Cincinnati, Ohio. The scope of this contract is research and engineering services for the areas of pollution prevention, waste minimization and treatment, and technology for site restoration. His dissertation research at Princeton University dealt with radionuclide migration from radioactive waste burial grounds. The findings were published in *Science* and *Nature* and have had broad implications for the field of radioactive waste disposal.

Since joining Battelle in 1978, Dr. Means has been involved in over 100 different research projects dealing with environmental geochemistry. This included a 9-year involvement in the Salt Repository Project, which investigated the suitability of a bedded salt site in the Palo Duro Basin of Texas for use as a high-level nuclear waste repository. In the late 1980s, Dr. Means was the principal investigator of a study for the Nuclear Regulatory Commission on the mechanisms of leaching of spent fuel and radioactive waste solidified in borosilicate glass. Dr. Means was also the senior geochemist in a low-level radioactive waste siting study to determine the suitability of a proposed site in Illinois.

Relevant Experience

Technical Resources Document for Hazardous Waste Stabilization. Principal Investigator of a project for the U.S. EPA to update the Technical Resources Document on waste stabilization/solidification. This will be a user's guide for conducting benchscale treatability studies and performing field stabilization demonstrations.

Stabilization/Solidification of Hazardous Waste. Conducted/coordinated numerous projects involving: (a) geochemical equilibria assessments; (b) laboratory treatability testing; (c) full-scale field demonstrations, and (d) developing EPA treatability testing protocols. This has also included extensive interaction with local, state, and federal regulatory agencies. Waste forms studied range from sandblasting grit and metal-contaminated soils to oily sludges.

Technical Resources Document for the Remediation of Metal-Contaminated Sites. Principal Investigator of a project for the U.S. EPA to write a guidance document for the remediation of metal-contaminated sites. The document emphasizes technology selection based on the types and amounts of contaminants present.

Geochemistry of Nutrient Formulations for In Situ Bioreclamation. Studied the chemical equilibria of nutrient formulations for bioremediation, with emphasis on designing formulations that would minimize aquifer plugging from phosphate precipitation. Also studied the stability of hydrogen peroxide, a frequently-used oxygen source, and chemical additives for inhibiting peroxide decomposition.

Engineering Evaluations/Cost Analyses (EE/CA). Has written EE/CA reports for four different hazardous waste remediation projects. These reports are used in the treatment technology screening and selection process. Alternative treatment technologies undergo a two-phased screening process. The first set of criteria are technical feasibility, protectiveness of health and the environment, and timeliness. The second set of criteria are cost and administrative/managerial feasibility.

Low-Temperature Thermal Treatment of Fuel-Contaminated Soils. Coordinated a field demonstration of a proprietary low-temperature thermal treatment system on 1,200 cubic yards of fuel-contaminated soil at a fire training pit site at Naval Air Logistics field, Modesto, California. Battelle's role was to conduct soil and air (stack) sampling, provide oversight during the field demonstration, assist in regulatory interactions, and provide a third-party, independent assessment of the processes' effectiveness to the Navy.

Riflerange Pollution Assessment and Remedial Design. This project is assessing the nonpoint source pollution problem caused by lead and other metals in bullets at small arms practice ranges at DOE bases throughout the United States. The first phase of the project was the development of a problem statement, which defines the magnitude of the problem based on the volume of metal that is released to the environment and an assessment of metal fate and transport in different types of environments. The second phase of the project was the conceptual design of proposed approaches for minimizing lead pollution from rifleranges in the future.

Riflerange Stabilization Demonstration. Principal Investigator of a project wherein an innovative chemical stabilization process was developed and demonstrated on 180 cubic yards of lead-contaminated riflerange berm soils at Mayport Naval Air Station, Florida.

Chemical Mechanisms of Stabilizing Metals in Hazardous Waste. This project is applying basic geochemical equilibria to determine metal compatibilities and incompatibilities with various stabilization binders.

Recycling Sandblasting Grit into Asphalt. Dr. Means is serving as Principal Investigator on a project designed to evaluate the feasibility of recycling hazardous sandblasting grit into asphalt as a remediation alternative. This study results from a new policy by the California Environmental Protection Agency, which will permit this alternative for certain types of California-only (as opposed to RCRA) wastes, as a means of promoting a beneficial use of waste products. The alternative is being evaluated on a 3,000 cubic yard pile of waste sandblasting grit in the San Francisco area. A preliminary feasibility study will be followed by the field demonstration of the option on the entire 3,000 cubic yards of grit.

Recycling Sandblasting Grit into Portland Cement. Dr. Means was the Principal Investigator of a large-scale field demonstration to evaluate the feasibility of using spent hazardous sandblasting grit as a raw material in the manufacture of Portland cement. This approach takes advantage of the sand-

blasting grit's elevated iron and silica contents, which are necessary constituents for the manufacture of Portland cement. The demonstration successfully showed that the recycling can be conducted safely and that it produces a high quality Portland cement product.

Geochemistry Siting Study of a Low-level Radioactive Waste Repository. Dr. Means was Task Leader of the geochemistry task for a low-level radioactive waste disposal siting study in Illinois. Numerous ground water samples from different depths and aquifers at two candidate sites have been collected and chemically analyzed for major and minor elements and a variety of isotopes. The data were then evaluated for trends and statistically analyzed to interpret any implications for site hydrodynamics and potential radionuclide transport rates and pathways.

Site Survey and Assessment. Participated in several waste site surveys for industrial clients in Ohio. Supervised sampling and analysis and made recommendations on possible clean-up alternatives.

Clean Coal Combustion By-Product Reutilization Study. Task Leader in charge of compiling information on the physical and chemical characteristics of coal combustion desulfurization by-products from a wide variety of established and innovative desulfurization processes. Information was ultimately used in an assessment of the reutilization potential of the by-product materials and an in-depth market analysis.

Biodegradation Protocols. Task Leader on an EPA Study to compare and validate five different procedures for evaluating the biodegradability of organic compounds in aqueous geochemical environments.

Copper Chemistry. Coordinated round-robin analytical studies on the precision and accuracy of measurements of soluble copper in natural fresh waters. In a related effort, reviewed the speciation of copper in natural waters.

Scale Formation in Oil Wells. Collected field data and conducted laboratory measurements in support of a study for an industrial client to determine the chemical mechanisms of salt precipitation in deep oil wells. Recommended chemical treatment procedures to alleviate the scaling problem.

Desalinization of Sea Water. Evaluated chemical additions for inhibiting the flocculation of $CaSO_4$ during desalinization of sea water.

Organic Geochemistry of Deep Ground Water. Principal Investigator of a long-term study with the Office of Nuclear Waste Isolation to characterize the organic geochemistry of deep ground water from potential repository sites in salt and to evaluate the effects of natural organic compounds on radionuclide mobility.

Humic and Fulvic Acid Studies. Characterized and identified humic and fulvic acids in deep ground water from granitic bedrock from the Finnsjön and Sternö areas of Sweden.

Chelating Agents. Developed, based on conditional stability constant theory, a novel formation for the removal of calcium phosphate scale from nuclear reactor secondary cooling environments.

Chelated Radioactive Wastes. Reviewed current nuclear industry practices for the decontamination of nuclear reactors and made recommendations to the Department of Energy for the treatment and disposal of chelated radioactive wastes.

Acid Rain. Studied the chemical equilibria of organic acids in acid rain, particularly the contribution of organic components to acidity.

Accelerated Environmental Testing. Served as Deputy Program Manager on a large environmental testing program on proprietary data relay connectors.

Silica Chemistry. Analytically characterized speciation of dissolved and colloidal silica in power plant make-up water samples.

Polymer Chemistry. Characterized the dissolution characteristics and transformation products of a proprietary co-polymer used in borehole and shaft sealing.

Uranium Mine Tailings. Examined the chemical composition and rheological properties of uranium mine tailings from a New York state storage site.

Environmental Assessments. Assisted the Office of Nuclear Waste Isolation in the preparation of the environmental assessments for the high-level nuclear repository site in salt.

Site Characterization Plans. Major contributor to geochemistry sections of the Site Characterization Plan for the possible radioactive waste repository in bedded salt in Deaf Smith County, Texas.

Flue Gas Desulfurization. Evaluated chemical speciation of fluoride in flue gas desulfurization environments, resulting in the identification of aluminum-fluoride species, which has had important ramifications in subsequent corrosion studies.

Borosilicate Glass Leaching. Task Leader for a large program to evaluate the chemical mechanisms of simulated high-level borosilicate glass leaching in simulated ground water. Includes numerous experimental programs, including an evaluation of experimental artifacts, validation of a numerical model for glass dissolution kinetics, effects of glass devitrification on leach rates, and effects of natural organic acids on leach rates of transition metals and transuranics in borosilicate glass.

Spent Fuel/UO_2 Leaching. Conducted long-term experiments examining the dissolution rates of UO_2 and radionuclides in spent fuel in simulated ground water in realistic deep geologic repository geochemical environments. The spent-fuel experiments were conducted in Battelle's Hot Cell Facility.

Professional Recognition and Affiliations

Phelps-Dodge Fellowship, Princeton University 1976
Harold Dodd Fellow, Princeton University 1977-78
Listed in: "American Men and Women in Science"
"Who's Who in Technology Today"
"Who's Who in the Midwest"

Principal Research Scientist
Toxicology and Pharmacology Department

Education

B.S., Biology, University of Detroit, 1975
Ph.D., Biochemistry, Michigan State University, 1981
Diplomate of American Board of Toxicology

Qualifications

Dr. Sabourin has more than 15 years of experience in areas such as inhalation toxicology and metabolism studies.

Relevant Experience

Toxicology. Has been involved in studies of the uptake, metabolism and excretion of gases and other volatile compounds, such as benzene, glycol ethers, and butadiene. Has hands-on experience in the construction, calibration, and operation of inhalation exposure systems and knows vacuum-line methods of measuring gases and vapors. Has been actively involved in isolation and identification of metabolites. He has also been actively involved in metabolism of compounds using subcellular preparations in vitro. Dr. Sabourin has been Study Director on numerous studies carried out under GLP guidelines. Has directed inhalation toxicology studies of pharmaceutical candidate compounds in rats and dogs and has directed metabolism studies required for product registration of agricultural products.

Professional Recognition and Affiliations

Inhalation Specialty Section, Society of Toxicology
Mechanisms Specialty Section, Society of Toxicology
Sigma Xi
Society of Toxicology

Relevant Publications

Sabourin, P. J., B. A. Muggenburg, R. C. Couch, D. Lefler, G. Lucier, L. S. Birnbaum, and R. F. Henderson. 1992. Metabolism of [^{14}C]Benzene by Cynomolgus Monkeys and Chimpanzees. Toxicol. Appl. Pharmacol. 114, 277-284.

Dahl, A. R., J. D. Sun, L. S. Birnbaum, J. A. Bond, W. C. Griffith, Jr., J. P. Mauderly, B. A. Muggenburg, P. J. Sabourin, R. F. Henderson. 1991. Toxicokinetics of Inhaled 1,3-Butadiene in Monkeys: Comparison to Toxicokinetics in Rats and Mice. Toxicol. Appl. Pharmacol. 110, p. 9-19.

Sabourin, P. J. 1990. "Pulmonary Toxicity" in Introduction to Biochemical Toxicology (Ed. E. Hodgson, P. Levi) Elsevier Science Publishing Co., New York, NY, in press.

Sabourin, P. J., M. A. Medinsky, W. E. Bechtold, and R. F. Henderson. 1989. Disposition of Benzene in Animals and Man. Adv. Modern Environ. Toxicol. 16, 153-176.

Sabourin, P. J., J. D. Sun, J. T. MacGregor, C. M. Wehr, L. S. Birnbaum, G. Lucier, and R. F. Henderson. 1990. Effect of Repeated Benzene Inhalation Exposures on Benzene Metabolism, Binding to Hemoglobin and Induction of Micronuclei. Toxicol. Appl. Pharmacol. 103, 452-462.

Medinsky, M. A., P. J. Sabourin, G. Lucier, L. S. Birnbaum, and R. F. Henderson. 1989. A Toxicokinetic Model for Simulation of Benzene Metabolism. Exp. Pathol. 37, 150-154.

Sabourin, P. J., W. E. Bechtold, W. C. Griffith, L. S. Birnbaum, G. Lucier, and R. F. Henderson, 1989. Effect of Exposure Concentration, Exposure Rate, and Route of Administration on Metabolism of Benzene by F344 Rats and B6C3F$_1$ Mice. Toxicol. Appl. Pharmacol. 99, 421-44.

Henderson, R. F., P. J. Sabourin, W. E. Bechtold, W. C. Griffith, M. A. Medinsky, L. S. Birnbaum, and G. Lucier. 1989. The Effect of Dose, Dose Rate, Route of Administration and Species on Tissue and Blood Levels of Benzene Metabolites. Environ. Health Persp. 82, 9-17.

Medinsky, M. A., P. J. Sabourin, G. Lucier, L. S. Birnbaum, and R. F. Henderson. 1989. A Physiological Model for Simulation of Benzene Metabolism by Rats and Mice. Toxicol. Appl. Pharmacol. 99, 193-206.

Sabourin, P. J., J. D. Sun, L. S. Birnbaum, G. Lucier, and R. F. Henderson. 1989. Effect of Repeated Benzene Inhalation Exposures on Subsequent Metabolism of Benzene. Exp. Pathol. 37, 155-157.

Education

B.S., Biology, Heidelberg College, 1970
M.S., Dairy Science—Specialization: Reproductive Physiology, The Ohio State University, 1974

Qualifications

Mr. Wilkinson is a member of the General Toxicology Department. He manages a variety of large toxicity studies in various species for government agencies and private industry. His formal training is in reproductive physiology, biology and chemistry. Also, he has had extensive experience in immunology (RIA development) and has coordinated many programs requiring multi-disciplinary approaches in drug/chemical safety evaluations for the past 14 years.

Relevant Experience

Coordinate or assist in proposal preparation and study design for numerous industrial- and government-sponsored programs. Preparation of study protocols and interaction with clients and Battelle personnel in the execution of research projects. Also, responsible for day-to-day study operations, presentation of data to clients for ongoing programs, and report generation as well as project cost management. Responsible for maintaining project compliance to all regulations for various government agencies.

Served as Study Director, Principal Investigator or Study Toxicologist at Battelle for numerous industry- and government-sponsored programs:

Dermal Irritation Studies. Evaluated the dermal irritancy of three fungicide formulations and liquid fertilizers in the rabbit; evaluated the dermal irritation potential of surgical adhesives in rabbits; evaluated the dermal irritation potential of the M-258A-1 Skin Decontamination Kit and four candidate Decon I formulations for substitution in the kit. Evaluated dermal irritancy of liquid ammonia and thermal conductants in rabbits via whole-body exposure. Evaluated the dermal irritation potential of a pesticide in rats to establish dose levels in pharmacokinetic studies.

Dermal Sensitization Studies. Evaluated the dermal sensitization potential of surgical adhesives and industrial chemicals (N-methanol—acrylamide and ethylenediamine) using the Guinea Pig Maximization Test. Also, evaluated the skin sensitization potential of two thermal-conductants containing sodium thiocyanate and an organophosphate pesticide in the guinea pig by the Buehler Test.

Ocular Irritation Studies. Evaluated ocular irritancy of thermal conductants in rabbits following whole-body inhalation exposure. Established procedures for coding, dispensing and distribution of reference compounds for in vivo and in vitro standardization of alternative methods to the Draize Eye Test. Evaluated the ocular irritancy of liquid fertilizers and an organophosphate pesticide in the rabbit.

Percutaneous Toxicity Studies. Determined the percutaneous toxicity of cosmetic ingredients to include range-finding studies, four 28-day studies and four 3-month studies in the rabbit. Conducted a 21-day repeated-dose dermal study of a pesticide in rabbits.

Drug Safety/Toxicity Studies. Simultaneously evaluated the toxicity of two drugs alone and in combination (eleven dose groups) by oral administration to rats and assessed calcium homeostasis by blood, bone and urine sample evaluations. Conducted one 3-month and two 1-month drug toxicity studies in both dogs and rats. Evaluated the ophthalmologic effects in rats by feeding cosmetic ingredients in the diet for 3-months. Conducted a one-month intravenous toxicity study of an NK-cell stimulator in rats. Directed three six-week intravenous toxicity studies of Anthracycline compounds in the dog to establish doses for a series of 13-week studies. Study Director for three 13-week intravenous toxicity studies of anthracycline compounds in dogs pretreated with a cardioprotective agent. Study Director for the toxicity evaluation of an anti-AIDS compound (NSC-620753) in mice and dogs. Study Director for 14- and 28-day toxicity studies of anti-AIDS compound (NSC-D629243) in hamsters. Directed a 14-day repeated-dose (with and without a 6-week recovery period) intravenous infusion study of an anthracycline derivative in beagle dogs. Evaluated the effects of chronic oral administration of a cyclosporin derivitive in beagle dogs.

Carcinogenicity Studies. Performed "special" subchronic studies in mice for 30 days and six months to determine the effects of feeding four grades of pentachlorophenol. Parameters included immunologic assessment by splenic lymphocyte blastogenesis, delayed hypersensitization, hemagglutination inhibition and plaque-cell forming response. Additional parameters included, behavioral assessment (grip strength, righting reflex, motor activity, rotor rod), biochemistry (cytochrome P-450), urinalysis, hematology, serum chemistry, histopathology, and determination of urinary and liver porphyrin content. Reported results for a one-year strain comparison Initiation/Promotion study of DMBA, MNNG/TPA and Benzoyl Peroxide in three strains of mice involving approximately 5000 animals.

Endocrinology Studies. Conducted an industry-sponsored program to determine the effects of feeding and withdrawal of ethylenethiourea and a commercial fungicide during a 6-month period in the rat; included correlation of histopathologic changes and patterns of endocrine function as evaluated by RIA of serum T-3, T-4, TSH, FSH, LH, GH, and PRL. Also, conducted a 1-year program sponsored by the Environmental Protection Agency to evaluate the effects of feeding ethylenethiourea and propylthiouracil to the rhesus monkey; included correlation of histopathologic, hematologic, and serum biochemical changes with endocrine function as evaluated by RIA of serum T-3, T-4, TSH, FSH, LH, GH, and PRL. Responsible for evaluation of serum T-3, T-4 and TSH in rats and mice in a two-year chronic study sponsored by the National Institute of Environmental Health Sciences to determine the effects of feeding ethylenethiourea. Determined serum T-3 and T-4 levels in cynomolgus monkeys following oral administration of thyroxine analogues in an industrial-sponsored program. Directed methods validation for the determination of arachidonic acid metabolites (Prostaglandin $F_{1\alpha}$ and Thromboxane) in rat plasma.

Antineoplastic Drug Toxicity Evaluation. Conducted a Phase I toxicity evaluation of Tiazofurin (NSC-286193). This included range-finding and LD_{50} studies in mice by intravenous injection at one and five daily dosing schedules. Toxicity studies included intravenous administration of the drug to mice and dogs at single and five daily dosing schedules. Reversibility of toxicity was assessed 33 or 56 days after administration by respective dosing schedules.

Inhalation Toxicity Studies. Conducted a program to determine the $LD_{50\text{-}1}$ for four carbonochloridic acids (chloroformates) and dimethyl carbonate in rats by whole-body exposure. Conducted four industrial-sponsored projects to evaluate the toxicity in rats by whole-body inhalation exposure to irritant dusts (6 hours per day, 5 days a week for up to 13 and 26 weeks). These studies also included interim necropsy groups at 12, 20, 65, and 180 days of exposure and recovery groups at 3 and

6 months following exposure. Performed two 10-day range-finding studies in rats (whole-body inhalation exposure, 6 hours per day) and in mice by nose-only inhalation exposure (one hour daily exposures). Also conducted acute and repeated inhalation exposure studies of ammonia vapor and sodium thiocyanate in mice and rabbits. Evaluated the effects of single, repeated inhalation exposure (10 exposures) and 13-week inhalation exposure studies of a curing agent in rats. Study Director for an acute (4-hour) and a 28-day nose-only inhalation exposure study of an antimicrobial agent in the rat.

Bioavailability/Pharmacokinetic Studies. Study Directory for the evaluation of the bioavailbility of an anti-AIDS compound (NSC-620753) in dogs and NSC-D629243 in hamsters. Reported the pharmacokinetic profile of atropine and its effects on various physiological parameters in the rhesus monkey.

Immunotoxicology Studies. Conducted an industrial sponsored program to evaluate the immunotoxicity of a synthetic antiinflammatory steroid in mice by oral administration for ten consecutive days. Test parameters included splenic lymphocyte blastogenesis, delayed-hypersensitivity, hemagglutination inhibition, plaque-forming cell function, pulmonary macrophage function, hematology, and histopathological evaluation. Hydrocortisone-21-acetate, cortisone acetate, and cytoxan were administered as positive control articles to separate animal groups using the same protocol. Developed methods to routinely evaluate the gross respiratory response and antibody production by intratracheal instillation of antigens to the unanesthetized guinea pig. Antibody production is assessed in sera by the passive cutaneous anaphylaxis assay (PCA) and by microimmunodiffusion during ten weekly instillations. This technique simulates the response produced by the inhalation route of exposure.

Prior Professional Experience

Research Scientist, Toxicology and Health Sciences Section, Battelle's Columbus Laboratories, Columbus, Ohio, January, 1981 to present
Researcher, Toxicology and Health Sciences Section, Battelle's Columbus Laboratories, Columbus, Ohio, August, 1977 to January, 1981
Supervisor, Polypeptide Hormone Department, Diamond Shamrock Health Sciences, Inc., Columbus, Ohio, April, 1975 to August, 1977
Technologist, Research Department, Searle Diagnostic Inc., Powell, Ohio, February, 1975 to April, 1975. Acquired by Diamond Shamrock Health Sciences, Inc., April, 1975
Research Associate, Department of Obstetrics and Gynecology, The Ohio State University, Columbus, Ohio, September, 1970 to September, 1972

Professional Recognition and Affiliations

Diplomate, (Board Certified) American Board of Toxicology (1986)
American Board of Toxicology - Recertification Examination (1990)
Toxicology and Pharmacology Department, Battelle Laboratories--Award for Scientific Excellence (1987)
Society of Toxicology - Ohio Valley Chapter

Technical Assurance Manager
Nuclear D&D Technology Section

Education

B.S., Chemical Engineering, University of Pennsylvania, 1956
M.S., Nuclear Engineering, The Ohio State University, 1971

Qualifications

For over 30 years, Mr. Zielenbach has been a task leader, principal investigator, and project manager in studies related to the nuclear fuel cycle. He has designed in-pile irradiation experiments and has been responsible for performing safety analyses for irradiation experiments, nuclear transport packages, and for various fuel cycle facilities. He is also experienced in performing appraisals and inspections, developing and administering QA programs, developing equipment concepts for handling nuclear fuels, and implementing applicable nuclear codes and standards. He has participated in fuel cycle programs for PuO_2 packaging, facility effluent evaluation, coprocessing, waste management, and beneficial uses of byproduct material.

Relevant Experience

Inspection of DOE Facilities. Currently involved in the Technical Safety Appraisal (TSA) process for DOE; has performed appraisals of operations at Fernald, H Canyon (SRP), Y-12 uranium facilities, Paducah GDP, PFP (Z-Plant), PUREX, HFEF, Hanford Tank Farm, and LBL. Member of H&S teams for Tiger Team appraisals at Pinellas, LLNL, LBL, and EG&G-Idaho. These have all involved group interaction in developing a team report. Performed reviews of physical protection programs at PUREX, Portsmouth GDP, and Pantex for the DOE inspection and evaluation (I&E) process.

Quality Assurance Programs. Currently provides the technical assurance overview and internal technical quality control for decontamination and decommissioning of Battelle's nuclear materials facilities. Developed and administered a quality assurance program for a plutonium oxide shipping container.

Safety Analyses of Engineered Systems. As task leader, conducted safety analyses and OSR development in response to DOE Order 5481.1 for several facilities at Portsmouth, Paducah, and Fernald. Developed the system descriptions and safety analysis to support the special nuclear materials license amendment request to NRC to allow incineration of low-level waste at Battelle's nuclear site. Developed the safety analyses to support the requests for irradiations of encapsulated materials in a variety of research reactors and was responsible for the design and operation of many of these experiments. Participated as a team member in developing structural and thermal analysis sections of safety analysis reports in support of NRC licensing requests for several nuclear shipping packages.

Fuel Cycle Activities. Developed the safety analysis for Battelle's request to NRC for an SNM/byproducts license amendment to allow incineration of low-level radioactive waste. Led studies to develop equipment and container concepts for packaging PuO_2 powder from reprocessing of spent fuel. Participated in an extensive study to define facility effluents from reprocessing and refabrication

for several proposed recycle fuel cycles; in a study of a Battelle concept for coprocessing and recycling actinides in LWR and LMFBR spent fuel as a safeguard and waste management measure; and in development of criteria for acceptance of nuclear waste at repositories.

Professional Recognition and Affiliations

Member, American Nuclear Society and Alpha Chi Sigma

APPENDIX B

RADIOLOGICAL SAFETY COMMITTEE CHARTER

Battelle
. . . Putting Technology To Work

CHARTER

of

RADIOLOGICAL SAFETY COMMITTEE (RSC)

Battelle
Columbus Operations

December 1992

Richard L Denning December 16, 1992 — Dennis R. Allen 12/16/92

Chairman, RSC — Date — Radiation Safety Officer — Date

D E Allen 12/18/92

CEO — Date

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APPENDIX A

DEFINITIONS A-1

APPENDIX B

GUIDELINES AND FACTORS FOR CONSIDERATION IN REVIEW OF CASES BY THE RSC B-1

1.0 RADIOLOGICAL SAFETY COMMITTEE (RSC) CHARTER

1.1 The purpose of this document is to describe the structure and role of the RSC as a part of the system established at the Battelle Columbus Operations for the control of potential radiological hazards in research activities and in the subsequent decontamination and decommissioning of radiologically contaminated facilities.

The radiological hazards considered here are those hazards to the public, the environment, and to Battelle staff and property which may arise from operations with ionizing radiation or radioactive materials. For the purposes of this document, radioactive materials additionally encompasses ionizing radiation producing devices. Also, the term safety is limited in scope to radiological safety, except where the non-radiological safety hazard creates or expands a radiological safety hazard.

1.2 General guidance in radiological safety matters is provided in Section 1350-9 of the BATTELLE OPERATING GUIDE (Ref. 1). More detailed guidance may be obtained in the "Radiation Protection Plan" (Ref.2) which is available from the Radiological Safety Officer (RSO), and in the NRC License for handling radioactive material which is available from the NRC Licensing Coordinator.

1.3 In order to control the radiological hazards associated with the possession, use and storage of radioactive materials, the acquisition and use of all radioactive materials must be reviewed and approved by the RSO. This includes, for example, materials acquired by purchase, internal transfer or client-supplied material. When the criteria discussed in this document are found to apply, work with radioactive materials must be reviewed by the Radiological Safety Committee (RSC) and approved by the Office of the Chief Executive Officer (CEO) before radioactive materials are obtained or work begins. If RSC review is not required, the work must be reviewed and approved by the RSO before radioactive materials are obtained or work begins. Every request for radioactive material use must be approved by the cognizant line managers prior to its submission to either the RSC or the RSO for review and approval.

2.0 RESPONSIBILITIES

2.1 Proposal Managers, Project Managers, Line Managers, and Division Vice Presidents

The primary responsibilities for safety in research operations rests with research management. Proposal managers must lay the ground work during proposal development for an adequate safety program and line managers under whose supervision operations are conducted must ensure implementation of the program. The supporting elements of the overall system do not relieve or modify the line manager's and division vice president's responsibilities. In the event that the RSC is asked to review a request to perform work with radiological materials, it is the responsibility of line management to provide adequate evidence that the requested work can be performed safely.

2.2 Environment, Safety and Health Department

The Radiological Services Group within the Environment, Safety and Health Department shares the responsibility for safe operations throughout the Columbus Operations by providing support to line management in the form of consulting services, and by offering radiological training courses for staff performing work with radiological materials and their managers. This group also performs reviews of requests to undertake radiological work and surveillances of work areas in which radiological work is performed. Radiological Services has authority and responsibility to exercise Stop Work Authority over the operation of a facility or an experiment believed to constitute an unacceptable potential for radiological hazard.

2.3 Radiological Safety Committee

The RSC shares with Radiological Services a part of the responsibility for the control of potential radiological hazards. The primary RSC functions are to review experiments planned by the research staff and to perform a periodic evaluation of the adequacy of radiological safety practices within BCO facilities. The RSC may be asked to review a proposed activity by the RSO or by the line management performing the activity or may decide to undertake a review at its own initiative. After reviewing a case the RSC can, by unaminous vote, recommend to the CEO that permission be granted to perform the requested activity. If the CEO concurs, he provides authorization to the cognizant line manager by memorandum. If the RSC determines that a substantial radiological risk exists as the result of discussions with the RSO, an audit of facilities, or the investigation of an event, it has the responsibility and authority delegated by the CEO as his agent to interdict the operation of a facility or an experiment.

2.4 Radiological Safety Officer

The Radiological Safety Officer (RSO) is the health physicist appointed by the CEO to represent him and the RSC in matters of radiological safety. The RSO has the responsibility and authority for initial review of proposed operations to determine if

RSC review is necessary or advisable, for approval of proposed operations which do not require RSC review and which are judged consistent with Battelle policy and radiological standards, and for surveillance and auditing of Battelle operations with respect to radiological safety matters. In the event that the RSC identifies a deficiency in operations requiring actions by line management, the RSO will provide follow-up and report on the status of any open items at the next meeting of the RSC. The RSO also has responsibility for identifying a need for review by the NRC License Coordinator. The RSO has the responsibility and authority to order the cessation or modification of any activities believed to constitute a substantial safety hazard or involve an unacceptable potential for such hazard.

2.5 NRC License Coordinator

The NRC License Coordinator is appointed by the CEO to assure that all radiological activities falling under the jurisdiction of the NRC are performed in a manner consistent with the NRC license. Line Management is responsible for assuring that all radiological activities are performed within the limitations of the NRC license. When a request is submitted to the RSO for approval to work with radioactive material, the RSO is responsible for performing an independent assessment of the need for the request to be reviewed and approved by the NRC License Coordinator. When a reivew is requested by Line Management or the RSO, the NRC License Coordinator must evaluate whether a proposed activity is consistent with the license or would require amendment. The NRC License Coordinator informs the RSO by memorandum of the results of his evaluation.

3.0 ORGANIZATION OF RADIOLOGICAL SAFETY COMMITTEE

3.1 Purpose of Organization

The purpose of the RSC is to provide, for the CEO, technical review of the safety of proposed and ongoing radiological activities at Battelle Columbus Operations facilities.

3.2 Scope of RSC Activities

3.2.1 The RSC is concerned with the potential hazards of ionizing radiation associated with radiological activities conducted within the Columbus Operations. The RSC evaluation as to whether any given radiological risk is substantial carries the authority delegated by the CEO. The RSC is concerned with the adequacy of radiological hazard analyses and control in experiments planned by the operating staff. The RSC is concerned both with the magnitude of the radiological risk and with the degree to which practical measures have been imposed to maintain radiation exposures to As Low As Reasonably Achieveable (ALARA). It is not concerned with improving operations in any way except with regard to radiological safety.

3.2.2 The RSC will not be concerned with non-ionizing radiation or non-radiological hazards except where they may contribute to the probability or severity of radiological hazards.

3.2.3 The RSC is not concerned with administrative matters such as the processing or approval of license applications except where they may directly affect the safety of Battelle staff or property, or the public. License applications and modification requests will be handled through the Battelle NRC Licensing Coordinator.

3.3 Specific Responsibilities of the RSC

3.3.1 The RSC is responsible directly to the Office of the CEO. The responsibilities and duties incumbent upon each member of the RSC shall be dispatched promptly and shall take priority over usual responsibilities.

3.3.2 The responsibilities of the RSC are the following:

(1) Advise the Office of the CEO in matters of radiological hazards,

(2) Determine the types of work which must be reviewed,

(3) Evaluate the hazard analysis of proposed work to assure the CEO that the associated risks will be maintained at the lowest practicable level when conducted as approved,

(4) Assure the CEO that the potential for radiological incidents has been reduced to acceptable levels when operations are conducted as approved,

(5) Review operational incidents to identify root causes,

(6) Perform a periodic review of radiation exposures of Battelle staff and the efficacy of the ALARA program, and

(7) Perform an annual appraisal of radiological activities.

3.4 Organization of RSC

3.4.1 The RSC is a committee of Battelle staff or consultants with broad experience in operations with radiological materials.

3.4.2 Members of the committee will be appointed by the Office of the CEO (OCEO) as needed. Appointments of committee members will be initiated by the Chairperson of the RSC by sending a recommendation to the OCEO.

3.4.3 The selection of committee members is based on the following principles:

(1) Each technical discipline relevant to the type of radiological activities performed at BCO shall be represented (e.g. health physics, nuclear instrumentation, radiation shielding, criticality, uses of radioisotopes in animal or medical studies, radiochemistry, decontamination and decommissioning and field studies).

(2) The RSO will be a member of the committee. He can be represented by a qualified alternate at an RSC meeting, if necessary.

(3) To the extent feasible, persons involved in the development or the conduct of an operation of a project cannot be considered as part of the quorum for review of that operation or project.

(4) A sufficient number of members (6 to 8) will be appointed as necessary to ensure a quorum of the necessary disciplines needed for adequate case review without undue delay.

(5) The Chairperson shall be designated by the OCEO. The term of the Chairperson shall not exceed three years.

(6) One of the members shall be designated as Secretary by the Chairperson. The term of the Secretary shall not exceed three years.

3.4.4 A current roster of RSC membership will be maintained by the Secretary of the RSC. A current listing of the Chairperson and Secretary will be maintained in the "Services/Support Group" section of the staff directory by the RSC secretary.

4.0 METHOD OF OPERATION OF RSC — APPROVAL FUNCTION

4.1 Introduction

4.1.1 A major function of the RSC is to review the radiological safety features of proposed new uses or modifications of approved uses of radioactive materials, to be sure that hazards to any person or property are reduced to the lowest practicable levels consistent with standard ALARA principles. If it is convinced that the plans, procedures, and precautions will maintain hazards to the lowest practicable level, the RSC recommends approval to the Office of the CEO and in so doing shares with the cognizant line managers and vice presidents the responsibility for safe operation if the experiment is conducted in the approved manner. Approval to conduct the proposed work is granted through administrative channels described later.

4.1.2 The rules to be followed in preparing for radiological activities and in determining the need for RSC review, and the actions to be taken, if review is required, are given below. The rules are discussed in the framework of the sequence of events leading to RSC review.

4.2 Preparing for Activities with Radioactive Materials

Guidance on procedures to be followed by persons who wish to prepare for operations with ionizing radiation or radioactive materials is presented in the Operating Guide (Section: 1350-9 Radioactive Materials and Ionizing Radiation). Additional guidance is given below.

4.2.1 Preliminary Discussions - All newly proposed or modified operations with radioactive materials must be discussed by the cognizant line managers with the Radiological Safety Officer (RSO). The line managers must provide sufficient documentation of the safety of the newly proposed or modified work to allow the RSC to perform independent verification of their safety. If line management has not requested review by the RSC, the RSO will make an independent assessment of the need for RSC review and will provide guidance in arranging for review and related matters. The RSO also determines whether review is required by the NRC License Coordinator.

4.2.2 Review and Approval of Uses of Radioactive Material for which RSC Review is Not Required - Requests for new uses and modifications of approved uses of radioactive materials for which RSC review is not required must be submitted to the RSO.

A special form "Radioactive Materials Application" (RMA) is used for documentation of these requests. Copies of this form with instructions are available from the RSO. The request for review and approval of the use and for the acquisition of the radioactive material for that use may be included in

the same form. Each approved RMA is identified by a file number in the upper right hand corner.

The RMA must be approved by each vice president and each cognizant line manager whose staff or facilities are involved in the use of the material before submitting the RMA to the RSO. All persons who are required to approve or sign the RMA will be provided a copy.

4.2.3 Procurement of Radioactive Materials - This includes any Radioactive Material from any source, i.e., purchase by requisition from a supplier, furnished by the client or donated by other suppliers, transfer within Battelle or "left-over" from previous work.

To obtain radioactive materials, the researcher must have an approved "Radioactive Materials Application" identified by the RMA number in the upper right hand corner. New projects requiring RSC review shall require approval prior to approval of the RMA.

All purchase requisitions for or requests for internal transfer of radioactive materials must reference the RMA number (and RSC case number, if any previous RSC review was performed) and must be approved by the RSO before being processed by Purchasing or the material is otherwise obtained.

4.2.4 Review by RSC - If the RSO concludes that any proposed use or procurement should be reviewed by the RSC, he shall inform the person making the request and his management and refer the matter to the committee.

4.2.5 Decontamination and Decommissioning Operations (DDO) — The scope of work performed under the DDO Group and specifically the Battelle Columbus Laboratories Decommissioning Project is of such a magnitude that a separate radiological protection organization has been established. While the RSO continues in an oversight function of DDO activities, the Radiological Protection Manager is responsible for the radiological protection program for the DDO's activities.

4.3 Criteria for RSC Review

The determination whether RSC review of a particular experiment is or is not necessary is based upon the potential radiological hazard associated with that work. The hazards with which the RSC is concerned are those affecting Battelle staff and property, public persons, private and public property, and the environment. Since the primary responsibility for operational safety rests with the cognizant line manager, the experimenter or his manager is responsible for doing a hazards analysis of sufficient depth to determine if review is required. If a review is required, it is the responsibility of the applicant to demonstrate to the RSC that he has completely identified the hazards and designed adequate controls for the hazards.

Guidelines are provided in the following section to identify those activities which require RSC review. In some cases there may be some question whether review is mandatory, but review may be considered advisable. The cognizant division vice president or the RSO may request that an RSC review be performed.

4.3.1 Mandatory RSC Review - Review by the RSC is required where:

(1) Radionuclides are proposed to be handled in unsealed form in greater than 200 millicurie quantities.

(2) Large quantities (Curie quantities) of radioactive materials are proposed to be used as sealed sources.

(3) Highly reactive, flammable, explosive, toxic or corrosive materials are proposed to be used which are also radioactive or are to be used in conjunction with radioactive materials.

(4) High pressure systems or other high energy systems are to be used in conjunction with radioactive materials.

(5) Plans for construction or significant alterations of a facility or equipment are proposed for experiments that require review. The plans must be reviewed before construction or alteration is begun. A construction engineer may be asked to sit on the review committee as a consultant at the discretion of the Chairperson. The facility design must include consideration of possible radioactive release by natural forces and external threats.

(6) New, untried, or unusual processes or procedures or significant changes in existing processes or procedures are proposed in experiments that require review. (This includes the beginning of operations in a new or significantly altered facility or with new or significantly altered equipment.)

(7) In experiments where new or inexperienced researchers and staff members will be involved. The request for review must include a discussion of how the personnel will be provided orientation and training before performing hands-on work.

All persons must be provided orientation and training prior to being assigned to work with or be associated with radiation producing devices or radioactive material.

(8) There is a real potential for occurrence of any of the situations listed in Appendix B.

4.3.2 Review Unnecessary - Reviews of the individual experiments or operations are not required in the following cases:

(1) When the experiments are to be conducted under Approved Standard Procedures. (See 4.5.7)

(2) Where the case is of such a nature that it may be approved by the Radiological Safety Officer. Such approval is given, for example, for minor changes in operating procedures or materials, where the added hazard is minimal.

4.4 Requesting RSC Review

4.4.1 Requests for review of a use will be submitted by the cognizant line manager (or by the investigator, with approval of the cognizant line manager) and approved by the cognizant vice president. Requests for review will be made by completing an RMA and submitting the form to the RSO.

4.4.2 The Review Request - The review request must include the following elements:*

(1) A general description of the project.

(2) Description of operations, processes, and procedures.

(3) Time schedule of the project.

(4) Facilities and equipment to be used.

(5) Identification of personnel who will direct and perform the work with their experience and training.

(6) Careful and thorough hazards analysis.

(7) Precautions to be taken to prevent potential safety problems.

(8) Contingency plans for emergencies.

(9) Health physics procedures, considerations and/or commitments.

(10) Discussion of radioactive scrap and waste that will be generated and the specific arrangements that have been made for disposition of the scrap and waste.

(11) Discussion of the disposition of contaminated equipment and the facility on completion of the project.

---

* Consult the RSO for additional information necessary in the request; also see Section 4.3 and Appendix B.

(12) A RMA will be attached to provide the other general information not described above.

4.5 Review Procedures

The procedures listed below are to be followed in requesting a review.

4.5.1 Preparation of Review Request - At the earliest possible time the experimenter will prepare the request for review, have it approved by his line manager, his vice president, and all other vice presidents and line managers whose staff or facilities may be involved, and forward a copy for each RSC member to the RSO or the RSC Chairperson. In addition, one copy should be made for the Secretary of the RSC/RSC Files unless the information is classified, in which case the copy should be made for the RSC Chairperson/RSC Classified Files (if the Chairperson does not have the proper clearance, a cleared member will be assigned responsibility).

4.5.2 RSC Review - Upon receipt of the request, the Chairperson will assign to the case a number of the type RSC-1-7, where RSC-1 indicates that the RSC activities are an historical continuation of the Radioactive Materials Subcommittee (RSC-1), and -7 indicates the seventh case they have reviewed. As soon as possible, but not later than seven (7) working days after receipt of the request, the committee will meet to act upon the request. A quorum required for RSC review shall include:

(1) At least two-thirds of the active members.

(2) The RSO or a qualified designated representative.

(3) At least one member from each of the technical disciplines necessary to adequately assess potential hazards.

(4) No member who is the experimenter, his section manager, the facility supervisor or his section manager, or any other person who has contributed significantly to planning the experiment or will be directly concerned with its conduct.

(5) The committee may, on its own initiative, request and require the attendance of any person who can provide information needed for the review.

4.5.3 RSC Action - The committee can take any of several actions on the request:

(1) It can, by unanimous vote, reject the request.

(2) It can, by one or more dissenting votes, return the request to the originator with instructions to modify it in one or more particulars. The modified request will then be reviewed by the Chairperson, or may be

reviewed by a subset of the committee or the whole committee for acceptable responses.

(3) It can, by unanimous vote, recommend approval of the request. In voting for approval, the committee may also recommend that certain restrictions, stipulations, conditions or instructions be imposed as part of the CEO's memo. The recommendation for approval from the RSC to the OCEO must contain the following information:

- Name of each member and consultants, if any, sitting on the case.
- Significant safety questions raised during the review and conclusions reached concerning each.
- Restrictions, stipulations, conditions, or instructions recommended to be imposed by the committee.
- Date and case number.

4.5.4 Appeal of RSC Action - The committee action can be appealed to the OCEO. At its discretion, the OCEO can establish a special committee to review the action and to make recommendations to the OCEO.

4.5.5 Approval - If the committee recommends approval of the request, the Chairperson will prepare a memo for the CEO's signature addressed to the Vice President of the cognizant line manager (and to any other vice president whose staff or facilities may be involved) giving approval for the conduct of the experiment, including any stipulations which may need to be imposed. The CEO or his designate, if he approves, will sign the memo and forward it to the vice president(s). It will be the responsibility of the vice president(s) to notify the people concerned with the matter.

4.5.6 Maintenance of Records - If the records are unclassified, complete records of each committee action will be maintained by the Secretary in RSC files. If the records are classified, the classified documents will be maintained by the Chairperson in RSC Classified Files. It will be the responsibility of the researcher requesting review to gather all copies of the classified documents distributed to committee members (but not the copy to the Chairperson/RSC Classified Files) as soon as the review has been completed. Unnecessary classification should be avoided. Unclassified information concerning cases involving classified documents will be sent to and retained by the RSC Secretary, the Secretary/RSC Files, and the Chairperson\RSC Classified Files.

4.5.7 Approved Standard Procedures - There are often certain routine or recurring operations or procedures employed in an area or facility which are repeated in essentially the same way under the same conditions. These will be considered and approved as standard procedures for a specific facility and set

of conditions, and will remain in effect as long as the conditions and parameters remain as specified.

This provision is intended to relieve the researcher and RSC from repetitive reviews of identical operations. However, the RSO and RSC Chairperson should maintain cognizance of these operations. The researcher/line manager must notify the RSC when certain substantial operations are to begin as instructed in the stipulations included in the review recommendations.

5.0 OTHER FUNCTIONS OF THE RSC

5.1 Appraisal of Operations

5.1.1 The RSC will perform an annual review and appraisal of all BCO facilities in which radiological activities are performed. The committee shall conduct an annual review and appraisal of each of these facilities. The review shall include a tour of facilities in which radiological activities are performed. The committee will submit a detailed report of its review and appraisal findings to the OCEO with copies to the facility line management and the Radiological Safety Officer. The report shall consider, but not be limited to, all the areas listed above for appraisal.

5.1.2 The RSO will maintain cognizance of all operations involving potential radiological hazards. The RSO will periodically audit and appraise these operations and will discuss deficiencies observed with cognizant management and make recommendations for their correction or mitigation. The cognizant management (research management and supervision and/or staff group management and supervision) will take the recommended action at the earliest feasible time. Recommended actions that are not considered feasible will be discussed immediately with the RSO and a mutually agreeable alternative will be devised, if possible. If a mutually agreeable alternative cannot be devised, the cognizant management will present the matter to the RSC for review and disposition by the standard RSC procedures. The RSO will perform follow-up on any deficiencies in operations that are determined by the RSC or by the RSO in the performance of their reviews. At intervals consistent with good safety practices (at least semiannually), the RSO will submit written reports of observed radiological conditions to the Office of the CEO and cognizant management with copies to the Chairperson and Secretary/RSC files. The RSC will meet at least semiannually (including the annual audit) to review the findings of the RSO.

5.1.3 In addition to the Office of the CEO and cognizant line management, the Chairperson of the RSC and the RSO have the authority and responsibility to order the immediate cessation of activities in an operation or a facility that is judged being conducted in a manner grossly contrary to RSC and the CEO's approval or is judged to constitute an unacceptable radiological hazard to operations personnel, public persons, Battelle, or other private or public property, or the environment.

If such action is deemed necessary, the person ordering the shutdown will contact the immediate supervisor of the operation and request him to close down the operation as rapidly as possible and properly secure any equipment as necessary to protect the equipment and/or facility. The person will then inform the cognizant line manager, the vice president, and the Office of the CEO of his action and the reason. Such action may be appealed to the Office of the CEO.

The person will follow up with a written memorandum to the cognizant line manager and vice president explaining his action and outlining remedial action necessary to reinstate the operation. A request for reinstatement of operations must be submitted to the RSC. The RSC will review and dispose of the matter according to the standard RSC procedures as quickly as possible.

5.2 Review of Operational Incidents

5.2.1 Whenever there is an incident, near incident, or operation anomaly involving a substantial radiological safety hazard or potential hazard to Battelle staff or property or to the public, it is the responsibility of the cognizant line manager or facility supervisor to provide notifications and reports as required in Columbus Operations procedures for unusual incidents and procedures for compliance with 10 CFR, Part 21.

5.2.2 In the event of an incident constituting a serious substantial radiological safety hazard, the RSO will assemble a Preliminary Investigating Team* which will proceed at once to the site of the incident.

5.2.3 Line managers will maintain arrangements for following emergency plans to contact appropriate emergency response coordinators and to contact the RSC Chairperson in the event of a radiological emergency.

5.2.4 In the event of a serious accident or a fatality, defined as a Type A incident in the DOE Order 5484.1, the facility line management will take the following actions:

(1) Have the accident scene secured without being disturbed until the Preliminary Investigating Team has visited the scene.**

(2) Retain the arrangement of the equipment or articles involved in the accident undisturbed, or otherwise unaltered until the investigating team has had the opportunity to examine them.**

---

* Preliminary Investigating Team, chaired by the RSO, will make a preliminary inspection of the scene of the incident, verify that a full record of the incident is documented and that all evidence is preserved. It will have photographs taken immediately of the accident scene and any equipment involved, such as ladders, scaffolding, motor vehicles, laboratory equipment, etc. The photographer must not alter the arrangements of equipment. A brief preliminary report of the nature of the incident and a summary of the site inspection will be submitted to the RSC Chairperson.

** This action is required by the Department of Energy (DOE).

(3) Assist the investigating team in obtaining pertinent information and records.

5.2.5 As soon as feasible, the RSC Chairperson will examine the information collected by the Preliminary Investigating Team. If, in his judgment, additional information or investigation is necessary, he will request the Preliminary Investigating Team to continue or he will assign an ad hoc committee to complete the investigation.

5.2.6 An incident judged to constitute a substantial radiological consequence shall be reported to the RSC by the RSO. The Chairperson of the RSC and the RSO, after collecting and evaluating available information concerning an incident, shall make appropriate recommendations to line management for any further mitigative or corrective action that should be taken.

6.0 REFERENCES

1. "Radioactive Materials and Ionizing Radiation," Section 1350-9, Battelle Operating Guide.

2. "Radiation Protection Plan," Battelle Columbus Operations, draft, November 1992.

APPENDIX A

DEFINITIONS

APPENDIX A

DEFINITIONS

Cognizant Line Manager

The cognizant line manager is either the administrative head of the licensed facility where the experiment is conducted or is the manager of the personnel conducting the experiment if the facility is not licensed. Where more than one organization is involved, the manager of each involved organization is a cognizant line manager.

Emergency Coordinator

The person assigned the responsibility for assuming tactical control of emergency response activities in the event of a radiological emergency at the King Avenue Site.

Fissile Material

A nuclide, capable of undergoing fission by neutrons and sustaining a chain reaction for some configuration, mass of material and degree of moderation.

Licensed Facility

Throughout this document, the term "Licensed Facility" refers to those facilities described and approved in the documentation of the NRC license for activities with radioactive materials. The approved facilities and activities and the authorized types and quantities of materials may be obtained from the NRC license coordinator.

Activities with radiation or radioactive materials proposed to be done in facilities which are not clearly licensed for such activities should be discussed with the NRC license coordinator.

License conditions and their negotiation are considered fundamentally administrative affairs and are not the concern of the RSC. However, since the safety of an operation and the policy applicable thereto are often closely associated with compliance with license conditions, the RSC does wish to stress the need for the experimenter to have a full understanding of license requirements.

A current listing of the NRC license coordinator will be maintained in the staff directory.

NRC License Coordinator

The person appointed by the Office of the CEO to coordinate all administrative activities and communications regarding Nuclear Regulatory Commission (NRC) license applications, compliance, materials requirements, and restrictions.

Radiological

Of or dealing with radioactive substances or ionizing radiations from radiation producing devices.

Radiological Control Group (RCG)

The group responsible for overall control and recovery in the event of a radiological incident involving actual or imminent release of radiological materials beyond limits of the Battelle facility. This group is part of the overall Columbus Operations emergency organization and not a part of the RSC.

Radiological Control Group Coordinator

The person assigned to direct and coordinate the preparedness and the emergency response activities of the Radiological Control Group and it subunits stationed at West Jefferson.

Radiological Safety Officer (RSO)

The health physicist appointed by the Office of the CEO to represent the CEO and the RSC in matters of radiological safety.

Source Material

Source Material is defined by the Nuclear Regulatory Commission as uranium or thorium or any combination thereof, in any physical or chemical form or ores which contain by weight 0.05 percent or more of uranium, thorium, or any combination thereof. It does not include Special Nuclear Material.

Special Nuclear Material

Special Nuclear Material is defined by the Nuclear Regulatory Commission as plutonium, uranium 233, uranium enriched in the isotope 233 or isotope 235, or any other materials that the Commission determines to be Special Nuclear Materials.

APPENDIX B

GUIDELINES AND FACTORS FOR CONSIDERATION

IN

REVIEW OF CASES BY THE RSC

APPENDIX B

GUIDELINES AND FACTORS FOR CONSIDERATION IN REVIEW OF CASES BY THE RSC

I. Section 4.3 presents the conditions which require RSC review. In addition, review is required where a hazards analysis reveals a substantial potential for any of the following:

(1) The release of radioactive powders, dusts, fumes, or mists, greater than 1/10 Derived Air Concentration Values, into laboratory air where staff are not protected or the unplanned escape of radioactive materials into the environment.

(2) The use or formation of pyrophoric, flammable, explosive or highly corrosive substances in combination with radioactive materials.

(3) The use or development of high pressures in combination with radioactive materials.

(4) An exposure of greater than 50% of annual limit to a staff member internally or externally.

(5) Exposure in excess of minimal levels to persons of the general public or persons not considered radiation workers.

II. In review of proposed operations, special consideration should be given to:

(1) The potential for inadvertent release of radioactive materials to the environment or into the work area by conditions or forces associated with the operation or by natural forces.

(2) The potential for fire, explosion, pressures exceeding containment capability, burnout of filters, plugging filters by dense smoke and loss of ventilation by loss of power.

(3) The capability of the facility or equipment proposed to be used to function as appropriate; maintenance of equipment.

(4) Radioactive wastes that may be produced and the arrangements to dispose of the wastes.

(5) The measurement and control of effluents.

(6) Mixtures of radioactive and certain EPA regulated wastes which may be exceedingly difficult to dispose.

APPENDIX C

BCO RADIATION SAFETY MANUAL

APPROVALS

Dennis Clum 9/13/93

D. Clum Date
Radiation Safety Officer

Lowell E. Snodgrass 9 Sept 93

L. Snodgrass Date
Manager, Environment, Safety & Health Department

J Means 9/13/93

J. Means Date
Chairman, Radiological Safety Committee

Battelle Columbus Operations

RADIATION SAFETY MANUAL

Environment, Safety, and

Health Department

Radiation Safety Services

Battelle

. . . Putting Technology To Work

505 King Avenue
Columbus, OH 43201-2693
Telephone 4-7676
Emergencies 4-4444
cc:Mail ^Radiation Safety Office

EMERGENCY NUMBERS

Control Center

- King Avenue 4-4444
- West Jefferson 4-5435

When calling in an emergency, be prepared to state:

1. Your name
2. Location
3. Radionuclide and quantities involved
4. Brief description of incident
5. Call back number where you may be reached

For specific information on Radiological Emergencies refer to Page 54.

Battelle Columbus Operations

Radiation Safety Manual

Environment, Safety, and Health Department
Radiation Safety Services

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Statement of Purpose

The Battelle Columbus Operations (BCO) ***Radiation Safety Manual*** has been reviewed by the Radiological Safety Committee and is intended for use as guidance on radiation safety for divisions of BCO that store, transport and/or use materials and/or equipment which produce ionizing radiation. When adhered to, this manual will uphold industry standards for radiological safety of the public, the environment, and BCO workers as well as uphold the BCO commitment to As Low as Reasonably Achievable (ALARA) goals.

Federal and state regulations require a written radiation protection program, and this manual has been constructed to be consistent with Nuclear Regulatory Commission and Ohio Department of Health Administrative Code requirements concerning radiation protection. The guidelines set forth in this manual are minimum requirements and must be adhered to by all BCO personnel involved with radioactive materials. Divisions may use their own procedures; however, they must adhere to the guidelines of the ***Radiation Safety Manual*** and be approved by the Radiological Safety Officer (RSO).

The primary responsibilities for safety in research operations rests with research management. Proposal managers must lay the ground work during proposal development for an adequate safety program and line managers under whose supervision operations are conducted must ensure implementation of the program. The supporting elements of the overall system do not relieve or modify the line manager's and division vice president's responsibilities. (Excerpt from the Radiological Safety Committee Charter.)

Radiation Safety Training

I. Purpose

As part of the Battelle Columbus Operations (BCO) commitment to ALARA, all personnel requiring access to a restricted area must complete radiation safety training as per 10 CFR 19.12. The level of training required is dependent upon the type of equipment or source (sealed or unsealed) to be used, the amount of radioactivity, and the operation involved. The level of required training will be determined by the Radiological Safety Officer (RSO) per the Radioactive Material Application (RMA). The following paragraphs give the basic guidelines used for access approval.

II. Guidelines

A. Only those personnel who have completed the BCO Radiation Worker Training Course or equivalent, have been placed on an appropriate dosimetry program, as defined in the RMA, and are listed on an approved active RMA may work with radioactive material. A 4-hour refresher course is required annually. Radiation Safety Services (RSS) will notify the personnel and the division safety personnel at the time their refresher is due.

B. Those personnel who do not require routine access to restricted areas where unsealed sources are being used, and handle only sealed sources (the radiation level at 30 centimeters from the surface of the source container or housing cannot exceed 5 mrem per hour) are required to complete the General Employee Radiation Safety Course, have a dosimetry assessment by the RSO, and be on an active sealed source RMA.

In addition to laboratory personnel, the following personnel must complete the General Employee Radiation Safety Course to allow unescorted access to restricted areas:

1. Facilities personnel
2. Janitorial personnel
3. Receiving/Shipping personnel
4. QA personnel
5. Any personnel frequenting radiologically restricted areas

C. **Visitors** who require access to restricted areas must be escorted at **all times** by a properly trained escort. Depending upon the nature of the visit, visitors may need a dosimetry evaluation before access is allowed. Contact RSS as soon as you are aware (5 days notice is requested) that you will be escorting visitors.

D. To qualify as an escort, personnel must be trained for the area to be entered and must agree to keep the visitor within his or her line of sight at all times. **Remember, if you are escorting a visitor, you are responsible for that person's radiation safety.**

Note: Those personnel who have had a radiation worker training class but are no longer on an active RMA, and no longer work inside restricted areas need not complete the refresher course. However, before being reactivated on an RMA or resuming work inside a restricted area, those personnel would first be required to complete the refresher course. If more than 3 years has elapsed since the initial course was taken, the initial course would have to be retaken before radiation work can begin.

Personnel Dosimetry

I. Purpose

Dosimetry is the process of evaluating, recording, and reporting exposure received from ionizing radiation. External dosimetry is accomplished using Thermoluminescent Dosimeters, (TLD's). TLD's measure the exposure from radiation sources outside the body. Internal dosimetry is accomplished by bioassay, (e.g., urine samples and whole body counting) and measures the exposure from radiation sources inside the body.

II. Dose Terminology

Absorbed dose - The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Annual limit on intake (ALI) - The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

1 ALI = CEDE of 5 rems
or
CDE of 50 rems to any individual organ or tissue

Bioassay - 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.

Committed dose equivalent (CDE) $H_{T,50}$ - 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.

Committed effective dose equivalent (CEDE) $H_{E,50}$ - 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.

Declared pregnant woman - A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose equivalent (DDE) H_d - Applied to external whole-body exposure, this is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

Dose or **radiation dose** is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose equivalent H_T - The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Effective dose equivalent H_E - 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.

Exposure - Being exposed to ionizing radiation or to radioactive material.

External dose - That portion of the dose equivalent received from radiation sources outside the body.

Extremity - Hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Eye dose equivalent - The external exposure of the lens of the eye, taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Intake - Quantity taken into the body, e.g., by inhalation or ingestion.

Internal dose - That portion of the dose equivalent received from radioactive material taken into the body.

Limits - The permissible upper bounds of radiation doses.

Member of the public - 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.

Minor - An individual less than 18 years of age.

Occupational dose - 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.

Total Effective Dose Equivalent (TEDE) - The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

$$TEDE = DDE + CEDE$$

Total Organ Dose Equivalent (TODE) - The sum of the deep-dose equivalent (for external exposures) and the committed dose equivalent (to an organ or tissue).

TODE = DDE + CDE

Uptake - Quantity absorbed into systemic circulation.

III. Administration

A. Proper d[illegible]ograms are determined by Radiation Safety Services upon review and approv[illegible]adioactive Materials Application (RMA) and are administered by Dosimetry Servic[illegible]s. Compliance with dosimetry programs is mandatory in order to work with radioactive materials.

B. Conditions which require m[illegible]oring (10 CFR 20.1502)

1. External monitorin[illegible]

a. Personnel likely to receive 10% of federal limits.

b. Minors or declared pregnant women likely to receive 10% of their limits.

c. Anyone entering "High Radiation Areas".

2. Internal Monitor[illegible]ssay)

a. Personnel like[illegible] to receive > 10% of applicable ALI(s).

b. Minors or declared pregnant women likely to receive a CEDE > 0.05 rem.

C. Baseline bioassay samples shall be collected prior to the start of any work with an isotope(s) for which a baseline bioassay has not already been processed. Subsequent bioassays shall be collected on a routine basis as determined by Radiation Safety Services, with additional samples being taken as required in the event of a potential uptake.

D. All personnel participating in bioassay programs shall perform an "exit" bioassay upon termination of employment or if no further radioactive work is to be performed.

E. Personnel TLDs and bioassays are sent to an outside vendor for processing. The results are sent back in the form of exposure reports which are then evaluated by Dosimetry Services and RSS to ensure exposures are below BCO action levels.

F. Dosimetry Services will immediately report any recorded radiation dose in excess of the Battelle action levels to Radiation Safety Services so that appropriate actions can be taken to determine the cause and minimize further exposures.

G. Annual exposure reports are sent to each individual having been on a dosimetry program. All questions concerning individual exposures should be directed to the BCO ALARA Coordinator.

IV. Limits and Action Levels

Action levels are established with the ALARA goal in mind to ensure the safety of workers and the general public and to provide warning prior to exceeding any state or federal limits. The chart below outlines the dose limits of 10 CFR 20 and the action levels requiring RSO review:

Radiation Workers	**Federal Limit (rem/yr)**	**Action Level (rem/yr)**
More limiting of: Total Effective Dose Equivalent (TEDE) or Total Organ Dose Equivalent (TODE)	 5 50	 0.5 5
Eye Dose Equivalent	15	1.5
Shallow-dose Equivalent Skin Extremities	 50 50	 5 5
Occupationally Exposed Pregnant Woman (total for entire pregnancy)	0.5	0.1
General Public (annual exposure)	0.1	0.05

Radioactive Material Application

I. Purpose

All users of radioactive material at Battelle, both at King Avenue and West Jefferson, must submit a Radioactive Material Application (RMA) prior to receiving radioactive material. The RMA (see form pages 11 and 12) must be completed and processed for any and all radioactive materials. This includes, but is not limited to sealed sources, exempt quantities, and sources used within equipment or devices.

II. Responsibilities

A. Principal Investigator - completes the RMA and obtains appropriate approvals, submits the RMA to Radiation Safety Services (RSS), and distributes approved copies of RMA to all users. Also is responsible to notify RSS of all modifications to RMA.

B. Department Managers - ultimately responsible for the proper use and execution of all work involving radioactive materials within their department.

C. Radiological Safety Committee - provides a safety review function for work involving radioactive materials and represents the Office of the CEO in radiological safety issues referred to it by the RSO.

D. Radiological Safety Officer (RSO) - provides guidance and training on the proper handling of radioactive materials, and oversight to ensure approved use of radioactive materials is in compliance with Battelle radiological procedures and Nuclear Regulatory Commission (NRC) regulations and guidelines. The RSO will also approve or disapprove the RMA's and modifications.

E. Users - must be familiar with the approved RMA's restrictions and radiation safety practices deemed acceptable by Battelle Columbus Operations, and shall only perform work under RMAs for which they are listed as "Users".

F. Source Custodian - designated person on RMA who is responsible for the receipt, storage, inventory, and distribution of radioactive source substances.

III. Submittal of New RMA

A. As early as possible, but not less than 10 working days prior to study initiation, a completed RMA must be submitted to Radiation Safety Services for review. If possible, submit RMA at the same time as the PIF C. New RMA requests will be responded to within five (5) working days. The RMA must be approved prior to ordering or

receiving any radioactive material. If extenuating circumstances exist, RMA's can be accepted on shorter notice.

B. The RMA should be completed in accordance with the instructions listed on page 13. If all information is not complete and/or approvals have not been obtained, RSS shall return the RMA to the Principal Investigator, explaining why it is being returned and what actions need to be taken to correct it.

C. The RMA will be forwarded to the Radiological Safety Committee (RSC) for review if the RSO thinks additional guidance is warranted, for activities greater than 200 mCi are involved, or if any other criteria requiring RSC review are met. These criteria, as stated in the RSC Charter, are listed in Appendix E.

D. Upon approval of the RMA, it will be entered into the Radioactive Material Tracking System by RSS and copies will be distributed to the Principal Investigator. Should the RMA be denied, it will be returned to the Principal Investigator within five days of receipt (or an explanation of delay given).

E. All incoming radioactive material shipments shall be addressed to the Radiological Safety Officer (RSO) and are to include the RMA number on the shipping label.

F. The Principal Investigator is required to keep on file all active RMAs for which he or she is responsible.

G. Any laboratory authorized for radioactive material use will maintain a list of all active RMAs (with corresponding study numbers) visibly posted or in a clearly marked notebook within each lab.

H. The Purchasing Department will forward any and all purchase requisitions for radioactive materials, devices containing radioactive material, or ionizing radiation-producing machines to RSS for RSO approval.

Note: **To preclude any delay of project commencement, RMAs should be submitted as far ahead of their intended use as possible.**

IV. Modifications to RMA's

A. Any and all modifications to an existing or unapproved RMA must be submitted on the RMA Modification Form which may be obtained from RSS (see form RSS-002, page 14). These modifications are to be submitted by the Principal Investigator with the applicable manager's approval.

B. Modifications which would increase the authorized radioactivity or change the protocol of the experiment require RSO approval prior to the modification taking place.

C. The same time limitations which apply to RMA's shall also apply to modifications.

V. RMA Review

On an annual basis, Radiation Safety Services shall perform a review of each active RMA to ensure all information currently listed is accurate.

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Radioactive Material Application

Complete all non-shaded areas.

This form, upon approval, must be posted and/or filed in the section(s) performing operations.

RMA Number _____
RSO Approval _____
Date Approved _____
Distribution _____

1a. Project Number _____ 2a. Expected Start Date _____

1b. Section Number _____ 2b. Length of Study _____

3. For Use in Animals? __ Yes __ No 4. Client _____

5. Project Title _____

6. Principal Investigator _____ (Print Name) _____ (Signature)

Source Custodian _____ (Print Name) _____ (Signature)

Manager _____ (Print Name) _____ (Signature)

7. User(s) _____

8. Location(s):
(a) Where Used _____
(b) Where Stored _____
(c) Hood _____ Safe _____ Refrigerator _____
Other _____

9. Amount of Material Requested Annually From Date of Approval:
(a) Radionuclide _____ (e) Physical Half Life _____
(b) Total Activity _____ (f) Alpha Emitter? _____ Beta Emitter? _____
(c) Physical Form__gas__liquid__solid Gamma/X-ray? _____ Neutron Emitter? _____
(d) Radioactive Form __Unsealed ___Sealed
Assay date _____ S/N _____
*(e) Chemical Form/Compound(s) _____
*Attach copy of MSDS or Equivalent

10. Detailed Technical Abstract of Work to be Performed: _____

11. Is the chemical form of the radionuclide a known carcinogen, mutagen or other toxic agent? _____
(a) Can it be incorporated directly into genetic material? _____

Please complete reverse side

12. Radiological hazards associated with this work may be internal, external or both. Summarize hazards and protective measures to ensure personnel safety and laboratory cleanliness.

13. Describe frequency of radiological monitoring and person(s) responsible for monitoring:

14. Describe emergency actions to be implemented should there be a spill, airborne release or other credible emergency:

15. Estimate waste form, volume and activity. Describe arrangements for waste disposal:

16. Dosimetry Requirement(s):

17. Health Physics Comments:

Instruction Sheet for the Application to Use Radioactive Material
(Print legibly in blue or black ink)

(1-5) are self explanatory

(6-7) Do not use initials when writing names, print full name.

(8) Print the room number for each location where the material will be used or stored. Place an "X" next to the type of secured storage area which will be used for the material.

(9) The amount of material expected to be used annually or during the term of the particular study, which ever comes first. Ensure that the physical form block includes the material phase (gas, liquid, solid) and the source type (unsealed, sealed, special form). Remember to attach a copy of the MSDS or equivalent if one is available.

(10) Additional pages may be attached.

(11) Answer 'yes", "no", or "no information available" to the questions in this section.

(12) Describe the known radiological hazards associated with the material. Include the proposed protective measures to be taken to protect against these hazards.

(13) Describe the proposed radiological monitoring for the project.

(14) Describe the proposed emergency actions to be taken for plausible unusual occurrences during the project. Include specific actions to be taken to protect against hazards identified in Sections (11) and (12).

(15) Describe the estimated volume and activity of the project's waste. If the waste will be in a different form than the original material, describe the waste's form as in Section (9).

NOTE: Current forms may be obtained by calling the Radiation Safety Office at 4-7676, or by CC:Mail on Pathworks, **but all signatures must be originals**. Approval signatures for the following persons must be obtained in item 6 prior to RSS approval of the RMA:

Source Custodian
Principal Investigator
Manager

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RMA MODIFICATION FORM

(Complete all non-shaded areas)

RMA Number _____

Date of Mod _____

RSO Approval _____

Date Approved _____

Distribution _____

Change From _____

Change to _____

Principal Investigator Signature _____

Manager Signature _____

Health Physics Comments:

Shipment, Receipt, and Transfer of Radioactive Material

I. Purpose

This section provides guidance in the handling of radioactive material when it is being received or when the need arises to ship to another location. This section also addresses the transferring of material between the King Avenue and West Jefferson campuses.

II. Shipment - Sample Packaging

A. General

1. Contact Radiation Safety Services to ensure that available packaging meets Department of Transportation (DOT) requirements.

2. The Principal Investigator (PI) is responsible for providing the proper container for the isotope and quantity being shipped.

3. The authorized user shall request that the intended recipient send a copy of their Nuclear Regulatory Commission (NRC) or state license. A copy of the license shall be sent to Radiation Safety Services (RSS).

4. Each package to be shipped shall be inventoried and an "Excepted Material Declaration and Package Surface Radioactive Contamination Test" form (see form RSS-031, on page 18) will be filled out.

5. Contact Radiation Safety Services (RSS) to perform a survey of the external surface of the package before shipping. (Extension 4-7676)

6. No radioactive warning sign is required and should not be used on outermost container if radioactivity is less than limits contained in 49 CFR 173.423 (see table on pages 19 and 20).

7. Deduct the material shipped from Radioisotope Inventory Record (see form RSS-025, page 27.)

B. Packaging

1. A solution or solid substance must be contained within a thick-walled glass or plastic bottle with a tight seal. The container should be chemically inert to the sample. The sample shall then be placed in a secondary container. The amount of packing material used must be twice that required to absorb the liquid sample and sufficient to prevent movement of the primary container. If dry ice is necessary for transport, place samples in a polystyrene box with dry ice and then inside a heavy-duty cardboard box. If transport at ambient temperature is sufficient, pack the sample in a heavy-duty cardboard box with sufficient packing material to prevent movement of sample.

2. Plant tissues and soil samples must be placed in a thick walled glass or plastic container. Proper sample identification and a radioactive tag must be affixed to

the container. Place in a plastic bag and seal. Containers with a tight-fitting screw cap may be used as primary containers for soil.

3. Animal tissue must be placed in glass or plastic bottles with tight-fitting screw caps or similar container. The primary container must then be placed in a secondary container such as a plastic bag. These are then placed in a polystyrene box with dry ice and then inside a heavy-duty cardboard box.

III. Receipt

A. All incoming radioactive materials shipments shall be addressed to the Radiological Safety Officer (RSO) (as the recipient) and are to include the RMA number on the shipping label.

B. Receiving will notify RSS when the package arrives in order for a receipt survey to be performed.

1. Packages will be placed in Room 10-0-011 and kept there until released by RSS to the Principal Investigator, or designee, unless refrigeration is required in which case it will be placed in designated refrigerator in receiving.

2. After package has been surveyed, an orange Package Survey Tag (see Exhibit 1, page 17) will be placed on the package. If any packages are received untagged, please notify RSS.

C. Add material received to Radioisotope Inventory Record (see form RSS-025, page 27).

IV. Transfer Between King Avenue and West Jefferson

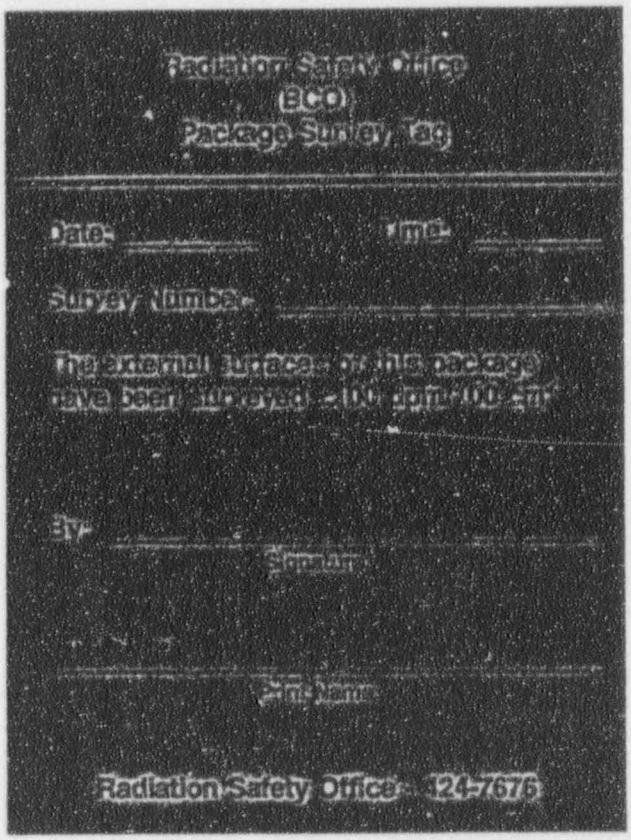
A. Inform Radiation Safety Services prior to transfer of material. The Radioactive Material Transfer (see form RSS-036, page 21) shall be used for such transfers.

B. Transfer of radioactive materials must conform to Department of Transportation (DOT) and courier regulations (Title 49, Code of Federal Regulations). Radioactive materials must be packaged to meet the same requirements as a shipment. Samples must be shipped to and from West Jefferson, or Battelle vehicles may be used. The use of privately owned vehicles for transfers of radioactive material is strictly prohibited. When shipping study samples of unknown activity, use the dosed activity unless further information is available.

C. Material transferred to West Jefferson or King Avenue shall be maintained on separate Radioisotope Inventory Record forms. West Jefferson and King Avenue inventories must remain separate due to different NRC License limits for the two locations.

D. In case of an accident on the road, call the Control Center at 424-4444.

EXHIBIT 1. PACKAGE SURVEY TAG



EXCEPTED MATERIAL DECLARATION AND PACKAGE SURFACE RADIOACTIVE CONTAMINATION TEST

(Complete all non-shaded areas)

Package consigned to: _____

_____

_____

RMA # _____

Isotope _____

Chemical Form _____

Physical Form _____

Total Activity _____ μCi or mCi

Consignor (sender) _____

Date _____

This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN2910.

The removable radioactive (beta-gamma) surface contamination on the external surface of this package does not exceed 100 dpm/100 square cm. wiped.

Surveyed by _____

Date _____

copies to: D. Clum, RSO, Rm 1410
Shipping

Types of Packaging

Excepted Packaging - must be only "strong, tight"

- Limited quantities (49 CFR 173.421)
- Instruments and articles (49 CFR 173.422)
- Articles containing natural uranium or thorium (49 CFR 173.424)
- *Empty* packaging containing residual radioactive material (49 CFR 173.427)
- Mailable packages - USPS publication #6 - same requirements as limited quantity and instruments/articles, except that 1/10th of activity is permitted in package

Activity Limits for Limited Quantities, Instruments and Articles (49 CFR 173.423)

Nature of Contents[a]	Instruments and Articles		Materials
	Instrument and Article Limits	Package Limits	Package Limits
Solids			
Special Form	10^{-2} A_1	A_1	10^{-3} A_1
Other forms	10^{-2} A_2	A_2	10^{-3} A_2
Liquids			
Tritiated water			
< 0.1 Ci/liter	--	--	1,000 curies
0.1 to 1.0 Ci/liter	--	--	100 curies
> 1.0 Ci/liter	--	--	1 curie
Other liquids	10^{-3} A_2	10^{-1} A_2	10^{-4} A_2
Gases			
Tritium[b]	20 curies	200	20 curies
Special form	10^{-3} A_1	10^{-2} A_1	10^{-3} A_1
Other forms	10^{-3} A_2	10^{-2} A_2	10^{-3} A_2

a For mixture of radionuclides see Section 173.433 (b).

b These values also apply to tritium in activated luminous paint and tritium absorbed on solid carriers.

DOT TYPE A QUANTITIES		
Nuclide	A_1 (Ci)	A_2 (Ci)
H-3	20.0	20.0
C-14	1000.0	60.0
P-32	30.0	30.0
Na-22	8.0	8.0
Cs-137	30.0	10.0
Ir-192	20.0	10.0

Selected Isotopes taken from 49 CFR 173.435

A_1 Maximum amount of special form (encapsulated or massive solid metal) material allowed in a Type A package, such that its escape from the packaging would cause only a direct radiation hazard.

A_2 Maximum amount of normal form or non-special form material allowed in a Type A package, such that its escape from the packaging would present both a radiation and a contamination hazard.

Type A Package Designed and tested to resist normal transport conditions without leakage.

Type B Package Designed and tested to retain its contents during both normal and accident conditions (10 CFR 71.73).

RADIOACTIVE MATERIAL TRANSFER

Instructions:

1. Complete this form for all transfers of radioactive material between the King Avenue and the West Jefferson campuses.

2. **Verify the authorization** of the intended receiver with Radiation Safety Services **before actual transfer.**

3. All packages transported on public roads **must comply with the shipping regulations** of the U.S. Department of Transportation. (See Tables on Page 19 and 20)

4. **Send appropriate copies of this form to addresses shown when transfer is complete.**

Licensee Identification:

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

Transaction: ☐ KA to WJ or ☐ WJ to KA Date:_____

Material Description:

Isotope:_____Activity:_____ μCi or mCi

Form (compound):_____

Purchase Order #:_____ RMA No._____

This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN2910.

The removable radioactive (beta-gamma) surface contamination on the external surface of this package does not exceed 100 dpm/100 square cm. wiped.

Surveyed by:_____Date:_____

Sender sign here_____

Receiver sign here and keep copy_____

Send original to RSO: Dennis Clum
Room 1-4-10, (614) 424-7676

Storage and Use of Radioactive Material

I. Purpose

This section provides general guidelines to be followed for the safe storage, handling, and use of radioisotopes. The ALARA philosophy is the basis for the guidelines for the use of radioactive material.

II. Storage

Radioactive materials, when not in use, shall be stored in such a manner as to preclude the possibility of inadvertent radiation exposure of individuals either from external radiation or from movement of the radioactive material from the container into the laboratory/work area air or onto surfaces. Positive control shall be exercised over all sources of radiation at all times. The materials (when not in use or under surveillance) will be secured in a locked area, room, cabinet, or other suitable container (e.g., refrigerator) to prevent access to and exposure of unauthorized persons. Sealed sources such as the electron capture detectors in gas chromatographs (GC) need not be otherwise secured if they are connected to an actively used GC. In cases where a source is used in more than one location, current location shall be tracked using the **Sealed Source Location Log** (RSS-024, page 26).

A. Laboratory/work areas: Radioactive materials shall be stored in laboratories and work areas as approved on the Radioactive Materials Application (RMA) provided:

1. The materials shall be stored in designated facilities that are posted with "Caution Radioactive Material" signs indicating the isotope(s) used, person responsible, and phone number.

    a. Only Radiation Safety Services staff may initially post new laboratory entrances. This is done to ensure that Radiation Safety Services is aware of all posted laboratories.

    b. Once a laboratory is posted, the Principal Investigator is responsible for ensuring that all equipment used (centrifuge, hoods, refrigerators, etc.) with radioactive material is properly labeled with "Radioactive Material" stickers or tape.

    c. Only Radiation Safety Services staff may de-post laboratories. This is done to ensure that all laboratories receive the required release survey.

2. Radioactive gas cylinders shall be stored in a locked cabinet or room.

3. Secondary containment shall be provided for radioisotopes stored in glass containers.

4. Individual containers of radioactive material shall be properly labeled with "Caution Radioactive Material" signs or tape. Working samples (samples with unknown quantities actively being used in a study) shall be labeled as radioactive until such time as analysis is complete, at which time their labeling shall be completed if necessary. The labeling shall indicate the isotope, quantity, the study number, date labeled, and the radiation level, if ≥ 5 mrem at 30 cm from the container.

   a. Individual containers with quantities less than the amounts listed in Appendix C are not required to be labeled with quantity, but must still be labeled as "Radioactive Material".

   b. Scintillation vials are exempt from labeling requirements. Boxes containing scintillation vials shall be labeled as radioactive. Other items too small to label should be placed inside larger marked containers.

5. An up-to-date inventory of all radioactive material shall be maintained for each active RMA using the Radioisotope Inventory Record (see form RSS-025, page 27).

   a. Maintain an up-to-date total activity remaining for each RMA.

   b. Subtract (Activity Removed) from total quantities shipped or any activity disposed.

   c. Material transferred to West Jefferson or King Avenue shall be maintained on separate Radioisotope Inventory Record forms. West Jefferson and King Avenue inventories must remain separate due to different NRC License limits for the two locations.

6. **On a quarterly basis, an inventory of all current radioactive material** (unsealed) **shall be submitted to Radiation Safety Services** (see form RSS-026, page 28).

   a. One **Quarterly Radioisotope Report Form** (RSS-026) must be submitted for each active RMA.

   b. Quarterly reports are **not required** for RMAs which have been approved only for the use of **sealed sources**.

   c. **DUE DATES**: **April 15** - for 1st Quarter (Jan, Feb, Mar)

      July 15 - for 2nd Quarter (Apr, May, Jun)

Oct 15 - for 3rd Quarter (Jul, Aug, Sep)

Jan 15 - for 4th Quarter (Oct, Nov, Dec)

B. If a change in location of use or storage of radioactive materials is required which is not authorized on the RMA, a request must be made to the Radiological Safety Officer (RSO), and approval granted prior to the actual movement of radioactive material. This can be done by submitting an RMA Modification Form (see form RSS-002, page 14).

III. Use

A. Preparation of the work area: All work surfaces will be protected from contamination to the extent possible by means of metallic trays, plastic backed absorbent paper, strippable coatings, and/or plastic sheeting before commencing work with radioactive materials.

B. Personal protective clothing and equipment: The minimum clothing and equipment to be worn will be a laboratory coat, eye protection, and gloves. Additional equipment may be required by the RSO at the time of RMA approval. Protective clothing (except that which has been used with tritium only) will be monitored at the end of each day or upon conclusion of operations for the day. If protective clothing is suspected of being contaminated with tritium, it should be surveyed by smear wipe.

C. Personal monitoring (frisking): Surveying hands, shoes, and body for radioactivity before leaving a laboratory area after using unsealed radioisotopes, or where contamination is possible, and removing all loose contamination before leaving the laboratory. This shall not be applicable to laboratories approved only for tritium use.

D. Operations involving unsealed radioisotopes will be performed in glove boxes or fume hoods whenever possible. Radiation Safety Services should be contacted for assistance in any work performed outside of hoods.

E. Temporary or permanent shielding will be used to prevent excessive exposure to radiation as required by RMA.

F. Items such as tongs, forceps, clamps, and mechanical arms will be used to reduce exposure to radiation where required.

G. Personnel with open skin wounds will not work with unsealed radioactive material without an adequate waterproof covering on the wound and the approval of the medical officer.

H. Any operation which has an inherent possibility of releasing airborne activity in excess of occupational limits (10 CFR 20, Appendix B) will be conducted in hoods with absolute and/or charcoal filters designed to reduce the release of contaminants to the

environment. Personnel who perform activities which could release airborne activity should request guidance from Radiation Safety Services.

I. All laboratories shall maintain contamination level < 100 dpm/100cm^2, and shall perform routine surveys at a frequency no less than that specified in Section III of Radiological Monitoring (page 36).

J. Laboratory equipment contaminated to levels > 100 dpm/100cm^2 should be secured or contained in plastic bags or similar containers when not in use.

IV. Food, Drink, and Smoking Policy

A. In order to ensure the safety of workers from the potential hazard of ingesting radioactive material, the policy must be clear regarding the consumption of food, drinks, and smoking. In laboratories where hazardous, toxic, or radioactive materials are stored or used, the guidelines state explicity that eating, drinking, chewing, smoking, and applying cosmetics shall be prohibited.

B. Where offices are inside a restricted area, the following guidelines should be considered as minimum measures to ensure that no radiological intakes occur as a result of transporting consumables through a restricted area:

1. All office areas inside restricted areas shall be surveyed weekly and documented. (Entrance ways, doorknobs, desktops, and eating areas should be included in the survey).

2. No food, drinks, or smoking materials shall be set down anywhere inside a restricted area. They must be carried straight through to the office area.

3. All food, drinks, and smoking materials must be contained and covered while carried through the restricted area.

4. A positive air flow from the office into the restricted area must be maintained while eating, drinking, or smoking.

5. There must be strict adherence to personnel frisking requirements.

6. Lab coats should not be worn inside office areas.

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SEALED SOURCE LOCATION LOG

Date	Serial #	Transferred to: Name/Location	Time Out/INT	Time In/INT

RADIOISOTOPE INVENTORY RECORD

RMA #	Isotope		Room #'s		
Date	User	Activity Added	Activity Removed	Disposition	Balance

RSS-025 6/1/93

QUARTERLY RADIOISOTOPE REPORT FORM

PRINCIPAL INVESTIGATORS NAME(S):_____ QUARTER REPORTED:_____

RMA NUMBER:_____DATE REPORT PREPARED:_____
PERSON FILLING OUT THIS REPORT:_____PHONE NUMBER:_____

A copy of this form must be sent quarterly to Radiation Safety Services, and a copy kept in the laboratory by the Principal Investigator. If this report is not received by the due date listed, no further radioisotopes can be ordered or received by the Principal Investigator. Continued delay could result in suspension of the RMA. **DUE DATES: APRIL 15** for 1st Quarter (Jan., Feb., Mar.); **July 15** for 2nd Quarter (Apr., May, June); **Oct. 15** for 3rd Quarter (July, Aug., Sep.); **Jan. 15** for 4th Quarter (Oct., Nov., Dec.).

Please read instructions carefully. Please contact Radiation Safety Services with any questions regarding completion of this form.

CURRENT RADIOACTIVE MATERIAL INVENTORY

ISOTOPE	ACTIVITY ON HAND (μCi)	DATE INVENTORY DETERMINED	
			Please list all radioactive material in possession at the end of this quarter according to the Principal Investigator's radioisotope inventory records. It is not necessary to list each chemical compound, just indicate total activity for each radioisotope, in each room used. List inventory of waste stored as well as stock solutions and dilutions.

LABORATORY PERSONNEL CHANGES

NAME	DELETE	ADD	IF NAME CHANGE: NEW NAME	
				Please list all personnel currently working under this RMA. Also please list any people listed on the RMA (as users), who are no longer working under this permit as **DELETE**. Any new personnel who should be added to this permit under **ADD**. Indicate any name changes that occurred this quarter.

CURRENT RADIOISOTOPE USE AREAS (LABS)

ROOM NUMBER	LAB STATUS	
		Please list all areas where radioactive materials (including radioactive waste) are stored or used for this RMA (all areas posted with **"Caution Radioactive Material"** signs). **Active** - Laboratory where radioisotopes are routinely used and stored. **Storage Only** - Radioisotopes are only stored, not used. **Inactive** - Posted laboratory where currently no radioisotopes are present. **Close-Out** - If you no longer use a laboratory for radioisotopes and wish to have it surveyed for release and de-posted.

Housing and Handling of Radioactive Animals

I. Purpose

This section provides the specific conditions and methods for handling animals, bedding, and excreta from experiments involving radioisotopes administered to animal subjects. This section addresses only the radiation protection aspects of such experiments.

II. Guidelines for Use

A. Animals containing radioactive materials shall not be caged and/or kept in a laboratory except with the consent of the Radiological Safety Officer and/or his designee. Designated animal use laboratories will be approved through the Radioactive Materials Application (RMA).

B. All safety precautions for use of radioisotopes in laboratories must be followed.

C. Animals given radioactive materials shall be caged separately from other animals.

D. Cages shall be labeled with appropriate radioactive material warning signs or tape. Information on the label shall include the name of the person responsible for the experiment, the isotope, quantity (if greater than amounts listed in Appendix C), radiation level (if any), and the date of administration.

E. Prior to cleaning, cages must be surveyed for contamination, and decontaminated as necessary. Cages are to be labeled indicating that they have been decontaminated prior to routine cleaning. Radiation Safety Services will perform the release survey and provide the labeling for the cages.

F. Animals which receive radioisotopes and are not sacrificed at the termination of the study must be properly identified and controlled as specified on the Radioactive Materials Application (RMA). Radiological Safety Officer approval will be required prior to relocation of any such animals.

G. Provisions must be made (on RMA) for projects likely to produce large quantities of waste or involve unusual contamination potentials to assure that lab facilities are adequate.

H. Principal Investigators are responsible for assuring that animal caretakers and technicians are aware of potential hazards and are adequately trained and supervised in the observance of necessary precautions.

I. The requirements for isolation and ventilation shall be approved by the Radiological Safety Officer.

J. Animals or their products (milk, eggs, etc.) which have been administered radioactive materials shall not be used for human consumption.

Laboratory Ventilation Control

I. Purpose

The use of unsealed radioactive sources makes it necessary to ensure that all appropriate measures are taken to minimize the potential for airborne contamination, thus reducing substantially the potential for personnel intakes, and to prevent the release of effluents to the environment above Nuclear Regulatory Commission (NRC) limits. For that reason laboratories where certain unsealed sources are used must be equipped with ventilation devices to prevent the inhalation of radioactive material.

II. Activity Limits

The quantity of the radionuclide to be used is significant in determining how the workplace should be classified for radiation safety purposes. Table 1 is a guide for determining the proper workplace type based upon the amount of radioactive material, certain modifying factors (Table 2) and, the toxicity class of the material, (Table 3). An example of how the three tables are used can be found in Section VI.

Table 1. Activity Limits for Use of Radionuclides
(From The Health Physics and Radiological Health Handbook, pg. 402)

Toxicity Class	Type of Workplace		
	Type I	Type II	Type III
Very high	13.5 μci or less	13.5 μci to 13.5 mci	13.5 mci or more
High	0.135 mci or less	0.135 mci to .135 ci	0.135 ci or more
Moderate	1.35 mci or less	1.35 mci to 1.35 ci	1.35 ci or more
Low	13.5 mci or less	13.5 mci to 13.5 ci	13.5 ci or more

III. Modifying factors

Modifying factors are based on the type of operation being performed and can be applied to the activities of Table 1. These factors will either increase or decrease the need for additional ventilation or other engineering controls.

Table 2. Modifying Factors

Operation	Modifying Factor
Storage (stock solutions)	x 100
Simple wet operations	x 10
Normal operations	x 1
Complex wet operations with risk of spills and simple dry operations	x 0.1
Dry and dusty operations, volatile compounds	x 0.01

IV. Radionuclide Toxicity

The following table shows classifications of radionuclides based on their radiotoxicity for some of the more common isotopes used at BCO. This table, used in conjunction with the work-place activity limits table, enables the correct workplace type to be chosen for each radionuclide.

Table 3. Toxicity Classification Table (Selected isotopes)
(From the Health Physics and Radiological Health Handbook, pg. 401)

Very High Radiotoxicity	*Moderate Radiotoxicity*
	^{14}C ^{35}S
Am-241	^{32}P ^{51}Cr
High Radiotoxicity	***Low Radiotoxicity***
^{22}Na ^{125}I	^{3}H
^{45}Ca ^{131}I	

V. Lab Classification

A. Labs using unsealed sources should be classified according to the relative radiotoxicity of the isotope being used, the quantities being used, and the type of operation.

1. Type I Labs

- Should be set up for small quantities of low radiotoxic isotopes. Operations should be limited to those with low potential for airborne contamination problems.
- Normal room ventilation is sufficient and may be supplemented with continuous air flow into a fume hood.

2. Type II Labs

- Specifically designed for work with moderate quantities of low and moderate radiotoxic isotopes, or small quantities of high radiotoxic isotopes; airborne levels should be kept ALARA with the use of totally or partially ventilated fume hoods (minimum face velocity - 100 linear ft. per minute).
- High Efficiency Particulate Air (HEPA) filters should be placed so that they can be easily changed and checked for negative pressure gradient.

3. Type III Labs

- Specifically designed for work with large quantities of radioisotopes with high radiotoxic levels involving dry powdery composition or high spill potential.
- Operations should involve completely enclosed glove boxes or hot cells under negative pressure with filters and transfer boxes.

B. By reviewing the tables it can be seen that most of the radionuclides used at BCO are in the moderate to low radiotoxicity class and so **for normal operations any quantities greater than 1.35 mci needs at least a Type II laboratory** set up. As was previously discussed this type lab should be equipped with fume hoods and depending upon the particular isotope and quantity; a HEPA filter.

VI. Example:

A Principal Investigator has a project which involves using the following:

1. *1.0 mCi of P-32*
2. *Physical form: powder*
3. *Operation will involve mixing 250 µCi of powder into each of 4 pots of soil.*

Step 1. Go to Table 3 (Toxicity Classification Table) to determine the toxicity class. You will find that P-32 is classed as Moderate Radiotoxicity.

Step 2. Determine which Modifying Factor to apply to the amount of radioactivity to be used. In our scenario, we will be mixing dry materials, therefore we will use the Modifying Factor from Table 2, of 0.01. This Modifying Factor is then applied to the activity limits found on Table 1 (Activity Limits for Use of Radionuclides). All activity limits should be multiplied by 0.01. After doing so, we find that for this project a Type II laboratory should be used. We know this because after multiplying by 0.01, between 13.5 μCi and 13.5 mCi may be used in a Type II laboratory, for a radioisotope with a Moderate Toxicity Class.

Step 3. Finally, check the Lab Classification found on page 32, to ensure that the laboratory meets the requirements of a Type II Lab.

VII. Fume Hoods

A. Fume hoods and the associated ductwork should be constructed with smooth non-absorbent materials that will not deteriorate with chemical use.

B. Negative air flow should be continuous such that no air from the hood can escape from the hood into the workplace. The operation of doors, windows, or the suction of other fume hoods should not influence the constant air flow of a fume hood.

C. All fume hoods where operations using radionuclides are in process must be properly posted as Radioactive Materials Areas including the name and phone number of the responsible person, and the isotope. Fume hoods should be smeared as part of the routine laboratory survey (see Radiological Monitoring on page 35).

VIII. Ventilation Filters

A. Whenever the potential exists for radioactive effluents to exceed the regulatory limits (and Battelle Columbus Operations Radiation Protection Program limits) HEPA and/or adsorbent filters must be used. In a laboratory workplace the filter should be placed between the fume hood and the ventilation duct. HEPA filters, used for particulates, are made of a fibrous material and have a removal efficiency of 99.97%. Adsorbent filters, usually charcoal, are used for volatile compounds.

B. HEPA filters must be routinely tested to ensure that they maintain the required 99.97% installed retention efficiency. Table 4 on page 34 gives a complete list of all filter tests required.

IX. Radiological Controls

A. Dose rates from filters should be monitored routinely to ensure dose rates do not exceed the area posting, especially in areas where radionuclides emitting gammas and high energy betas are used.

B. Radiation Safety Services must be notified to supply constant health physics coverage whenever filters are to be changed out.

Table 4. Test and Minimum Test Frequency (1)
(ANSI N510-1975)

Test	Recommended Test Frequency
Visual Inspection	Before any test
Duct and housing leak test	Acceptance (2)
Mounting frame pressure leak test	Acceptance (2)
Airflow capacity, distribution and residence time tests	Acceptance (2)
Air-aerosol mixing uniformity test	Acceptance (2)
In-place leak test, HEPA filters	Acceptance, after each filter change, and at least annually (2,3,5)
In-place leak test, absorbers	Acceptance, after each adsorber change and at least annually (2,3,5)
Laboratory testing of adsorbent	Acceptance, before each adsorber change and at least annually (2,3,5)
Duct heater performance test	Acceptance and at 2-year intervals (1)
In-place tests, moisture separators	Not required
In-place tests, prefilters	Not required

NOTES: (1) Field tests of motors, valve and damper actuators, and fire protective systems are not included in this standard.
(2) Acceptance tests to be made after completion of initial construction and after any major system modification or repair.
(3) More frequent (e.g., 6 months) testing may be required following initial start-up of the system until a pattern is established. Tests may be made during a scheduled shutdown, and can often be made without shutting down the entire air cleaning system if proper facilities for test (e.g., prelocated aerosol injection and test ports) are provided.
(4) Adsorbents must be tested before installation or replacement of absorbers to establish suitability. Samples for laboratory testing should be taken from the system at the same time as routine in-place testing of the installed system to verify the condition of the adsorbent.
(5) Periodic in-place leak tests of cells for 100% recirculation systems located within reactor containments are not necessary if the following are complied with:

a. Periodic visual inspection and pressure-drop determination in accordance with this standard of HEPA filters and absorbers are made during scheduled shutdown;
b. HEPA filters are replaced at no more than five-year intervals if dirt build-up, pressure-drop increase, or mechanical damage has not required earlier replacement;
c. Adsorbent is sampled and laboratory tests made to confirm performance at scheduled refueling shutdown or at intervals not exceeding 720 hours of system operation for intermittently operated systems or for any system immediately following inadvertent exposure to solvent, paints, or other organic fumes or vapors which could degrade the performance of the adsorbent.

Radiological Monitoring

I. Purpose

The following guidelines provide specific instructions for the radiological monitoring of laboratory facilities involved in radioisotope work. In research facilities, application of the ALARA principle dictates that removable contamination greater than action levels shall not be tolerated indefinitely. Whenever contamination is detected, it must be removed promptly to prevent its spread and the possible exposure of other individuals. The Principal Investigator must assure that the necessary monitoring is performed, recorded, and reported. Routine evaluations of all radioisotope laboratories, including surveys for contamination, are also performed by Radiation Safety Services.

II. Selection of Methodology

A. The performance of a detailed contamination survey includes both direct frisking and smears of surfaces and equipment.

B. When H-3 is used, only smear surveys are required. At this time a cost-effective means of direct frisking for H-3 is not available.

C. Four types of instrumentation are commonly used at Battelle. Each method of monitoring has its limitations, and this information is provided to assist in the selection of the available equipment. If you are unsure of which method to use, contact Radiation Safety Services at 4-7676.

1. When a gamma emitting isotope, (e.g., Co-60, Cs-137, I-131) is the isotope to be monitored for, then the Eberline E-120, or equivalent, end window GM survey instrument is preferred.

2. When monitoring for beta isotopes such as C-14, either a PAC4/G-3 or a Ludlum Model 3 is recommended. Although the PAC4/G-3 has a higher efficiency for low energy betas, personnel may prefer to use the Ludlum Model 3 due to ease of use.

3. Liquid Scintillation Counting (LSC) of smear wipes may be used for the entire range of beta energies and is the preferred method for analysis of smear wipes.

D. Personal monitoring/frisking (surveying hands, shoes, and body for radioactivity) shall be performed before leaving a laboratory area after using unsealed radioisotopes, or where contamination is possible, and removing all loose contamination before leaving the laboratory. This shall not be applicable to laboratories approved only for tritium use or for areas using less than the quantities listed in Appendix C.

III. Frequency of Surveys

A. The appropriate frequency for performing routine laboratory surveys is determined by the nature and quantities of radionuclides, and the conditions of use. The frequency of routine contamination surveys is based on the total quantity of unsealed (dispersible) radioisotopes in use in a given laboratory. For example, if a 5 mCi vial is opened to take aliquots out, then a 5 mCi is considered to be in use. If a 5 mCi vial is sitting in storage and isn't opened, then it is not considered in use.

B. The minimum survey frequencies shown in the table below are to be interpreted as guidelines. In cases where contamination occurs regularly, the interval between surveys should be shortened. In no case, however, should any posted laboratory space using or storing unsealed radioisotopes be surveyed less than once per month. Radionuclide categories and data, including ALI's for commonly used isotopes, are given in Appendix B.

< 1 ALI	Personal frisking EVERY DAY and laboratory surveys EVERY MONTH when radionuclides are in use.
1-30 ALIs	Personal frisking EVERY DAY and laboratory surveys EVERY WEEK when radionuclides are in use.
> 30 ALIs	BOTH PERSONAL AND LABORATORY SURVEYS EVERY DAY when radionuclides are actually in use.

Example: From Appendix B we find that the ALI for C-14 is 2mCi. Therefore if you were using < 2mCi (<1 ALI) of C-14, laboratory surveys would be required monthly and personnel frisking would be required daily.

IV. Contamination Survey

A. Direct frisks (not required for H-3 use) should be performed prior to performing smear wipes.

B. Perform smear wipes using dry filter paper such as Whatman #2, 4.25 cm diameter (or equivalent). A surface of approximately 100 square centimeters should be wiped.

C. Smear general access areas first, then do source storage and use areas (work from areas expected to be low, to those that could be high). Be sure to smear all areas where activity was detected by direct frisk, if any.

D. All smear locations should be circled and numbered on the Laboratory Survey Report (form RSS-015, page 41). All smear survey results must be reported in dpms/100 square centimeters.

E. Smear wipes shall be placed in a scintillation vial and analyzed in a properly calibrated liquid scintillation counting system.

F. Count sheets shall be attached to the survey form. All surveys should be kept in the laboratory in which they were performed. Surveys will be reviewed by Radiation Safety Services during their routine survey audits.

V. Procedure for Using the Eberline Model 120 GM Detector

A. General Information

1. The Geiger Counter, Model E120, is used to detect and measure gamma and beta radiation.

2. It is powered by 2 "D" size batteries. The condition of the batteries may be checked on the front panel control.

3. Radiation intensity of the suspect area is read out on a large meter with a linear scale.

4. A three-way switch gives full scale sensitivities for selected ranges from 0 to 0.5, 5 or 50 mr/hr.

B. Operation of the Instrument:

1. Ensure instrument is calibrated and perform daily response check and battery check.

2. Turn the 3-way switch to desired setting (always work from highest scale to lowest).

3. Turn on the audio on the side of counter.

4. Direct hand probe toward the radiation or suspected radiation to be monitored, being careful not to contaminate the probe.

5. Wait for reading to stabilize. Record radiation level on Laboratory Survey Report (RSS-015).

6. When finished with instrument, turn off setting switch and audio.

VI. Procedure for Using the PAC4/G-3 Gas Proportional Instrument

A. General Information

1. The PAC4/G-3 gas proportional instrument may be used to detect all beta emitting isotopes except H-3.

2. The PAC4/G-3 gas proportional instrument is typically used for alpha detection. Please contact RSS for further instructions prior to using the PAC4/G-3 for alpha contamination surveys.

3. The instrument is portable, battery operated, and has a gas flow proportional type detector.

4. The count rate is displayed on a LIN-LOG scale for the Eberline PAC4/G-3. On the low or black needle scale (from 0 to 500 cpm) each division is 50 cpm. From 500 to 5000 cpm on the low scale, each division is 500 cpm. On the high or red needle scale (from 0 to 50,000 cpm) each division is 5,000 cpm. From 50,000 to 500,000 cpm on the high scale, each division corresponds to 50,000 cpm.

B. Operation of the Instrument

1. Starting: Rotate the Gas Flow control knob to the "Flush" position or pull the gas flow slide valve out to the second click. After flushing the air from the probe for one to two minutes, light the gas flowing from the probe exhaust to verify correct flow as evidenced by the flame being between one to two inches in height. Next, perform battery test by pressing the OFF-ON-BATT switch to the BATT position. Turn the probe power switch from OFF to 21B which is the beta-gamma setting. To change from "Flush" to "Operate" rotate the flow control knob to "Operate" position . The flame at this position should be approximately 3/4 of an inch. Extinguish the flame by quickly touching the base of the flame.

2. Remove the face protector from the detector. The detector face is very thin and easily punctured. Do not set the detector on any sharp objects.)

3. Monitoring: The detector must be held within 1/4 inch of the surface being checked and moved at a rate of approximately 1 to 2 inches per second.

4. Results must be recorded on the survey form (RSS-015) in dpms. The cpm reading on the meter must be divided by the efficiency of the detector for the given isotope. Contact Radiation Safety Services with any questions concerning counter efficiency.

5. To shut down instrument, move the gas flow control and the probe power switches to their "OFF" positions and replace the detector face protector.

VII. Procedure for Using the Ludlum Model 3 GM Detector

A. General Information

1. The Geiger Counter, Model 3, with a Model 44-9 pancake probe, is used to detect gamma and all beta emitting isotopes with the exception of H-3.

2. It is powered by 2 "D" size batteries which can be checked by moving the power switch to the battery position.

3. Instrument should always be used with the Audio in the "ON" position.

4. Range Multiplier Selector Switch: A six-position switch marked OFF, BAT, X100, X10, X1, X0.1. Turning the range selector switch from OFF to BAT position provides the operator a battery check of the instrument. A BAT check scale on the meter provides a visual means of checking the battery status. Moving the range selector switch to one of the range multiplier positions (X0.1, X1, X10, X100) provides the operator with an overall range of 0-200 mR/hr or 0-500k CPM (typical meter dials are 0-2 mR/hr or 0-5k CPM). Multiply the scale reading by the multiplier for determining the actual reading.

B. Operation of the Instruments

1. Ensure instrument is calibrated, and perform daily response check and battery check.

2. Turn the four-way switch to the desired setting.

3. Direct pancake probe toward suspected contamination area, being careful not to contaminate the probe.

4. The detector should be held within 1/2 inch of surface being monitored and moved at a rate of approximately 1 to 2 inches per second.

5. Results must be recorded on the survey form (RSS-015) in dpms. The cpm reading on the meter must be divided by the efficiency of the detector for the given isotope (approximately 10% for C-14 using a Ludlum 3). Contact Radiation Safety Services with any questions concerning detector efficiency.

VIII. Action Levels for Contamination Surveys

A. Removable Contamination (beta-gamma)

Level (dpm/100cm^2)	Immediate Actions Required
≥ 100 (in unrestricted area)	Restrict access and immediately decontaminate area. Re-survey to verify decontamination. May be released from access controls at RSO's discretion.
≥ 100 (in restricted area)	Decontaminate area at earliest convenience.
≥ 1000	Notify Radiation Safety Services. Post area as **Contaminated Area**. Decontaminate area as soon as possible, preferably by end of work day. RSS staff post-decon verification survey required.
≥ 10,000	Begin decontamination efforts immediately. Post area as **Contaminated Area**. Radiation Safety Services will perform air samples as necessary. RSS post-decon survey required. A stop work order may be ordered by the Radiological Safety Officer.

B. Fixed Contamination (beta-gamma)

Level	Immediate Action Required
≥ 1000 dpm/100 cm^2	Label the associated equipment or material as radioactive.
≥ 0.25 mRad/hr	Contact Radiation Safety Services for disposition. RSO approval for continued use.

IX. Calibration

A. To assure the reliability of the readings obtained with survey instruments, they **must be calibrated annually.**

B. At the time of calibration, efficiency checks should be performed for all isotopes the instrument is used for.

C. Battelle Columbus Operations (BCO)-controlled facilities at JN-2 shall be used for instrument calibration services whenever possible. Use of outside services for calibration of instruments used for radiological control purposes requires prior authorization by the RSO.

LABORATORY SURVEY REPORT

DATE:	INSTRUMENTATION USED		
TIME:	MODEL	S/N	CAL. DUE DATE
SURVEYOR:			
LOCATION:			
PURPOSE OF SURVEY:			

SMEAR RESULTS IN DPM/100CM^2 UNLESS OTHERWISE NOTED. ATTACH LSC PRINTOUT.

ACTION LEVELS:	Fixed: >1000 dpm/100cm^2	NOTIFY RADIATION SAFETY SERVICES OF ANY LOOSE CONTAMINATION ≥1000 DPM 100 CM^2.
RSS-015	≥0.25 mRad/hr.	
	Loose: ≥100 dpm/100cm^2	

Radioactive Waste Management

I. Purpose

Proper use of radioactive material includes the correct handling, packaging, and storing of the waste. It is the responsibility of the laboratory personnel to assure that radioactive waste is minimized, packaged, and labelled properly.

II. Waste Reduction Methods

A. Minimization - preventing unnecessary contaminations will minimize waste.

B. Recycling - clean and reuse lab equipment when possible.

C. Segregation - radioactive and non-radioactive waste should be separated. Packing materials and boxes which have not been in contact with radioactive material should be disposed of in the regular trash after removal of any radioactive warning labels.

D. Preplanning - Review your procedures and determine which processes contaminate clean material and take measures to minimize the contamination, e.g., unnecessary transfers between pieces of glassware.

III. Types of Radioactive Waste

A. Waste shall be segregated and accumulated in the following categories.

1. Solid waste, without glass or sharps. Includes, but not limited to, bench paper, gloves, tyvek coveralls, rubber tubing, plastic bottles, small quantities of soil (< 500 grams), lab equipment, etc.

   a. Be sure it is double bagged.

   b. Yellow plastic bags with the "Caution - Radioactive Material" markings shall be used for outer most packaging.

2. Solid waste, glass, without sharps. Includes but not limited to glassware, TLC plates, bottles, oxidizer boats, etc.

   a. Be sure it is placed in a metal or plastic container.

3. Solid waste, "SHARPS". Includes pipets (glass or plastic), syringes, hypodermic needles, scalpel blades, etc.

   a. Be sure it is boxed, or placed in a metal or plastic container before placing in a bag.

4. Solid waste, De Minimis. For Battelle purposes, animal carcass and tissues in which the specific activity is no greater than 0.05 microCuries of C-14 or H-3 per gram of material and in which the radioactivity is evenly distributed.

   a. Be sure it is double bagged or stored in an equivalent container and kept frozen.

   b. Complete De Minimis Quantity Verification Animal Carcasses Form (RSS-032, page 47).

   c. Be sure it is kept frozen until ES&H determines when material can be collected and processed.

5. Liquid waste, water only. May not contain any type of organic or inorganic material that is above detectable limits.

   a. Accumulate in the labs in 1 quart to 5-gallon plastic containers. Keep closed with tightly fitting lids except when additions are being made.

6. Liquid waste, solvents. Includes, but not limited to, solvents and mixtures of acetone, toluene, xylene, methanol, and scintillation cocktail that does not meet the definition of De Minimis.

   a. Package in sealed containers, inert to the particular corrosive action of the substance.

7. Liquid waste, De Minimis. For Battelle purposes, liquid scintillation cocktail in which the specific activity is no greater than 0.05 microCuries of C-14 or H-3 per ml.

   a. Bulk liquids shall be packaged as in 5a above.

   b. Scintillation vials shall be packaged in the original boxes the vials came in, with the lids securely closed.

   c. Complete Liquid Scintillation Media De Minimis Verification Form (RSS-020, page 46).

      - List only one RMA per De Minimis Form. If a given box of scintillation vials has waste from three different RMA's, fill out three De Minimis forms listing the highest activity vial for each study.

8. Liquid waste, biological. Includes, but not limited to, animal excretion, fruit juices, cage wash that contains animal excreta and/or tissue, having the potential to decompose or putrefy.

a. Be sure it is stored the same as liquids named in Section 5a.

9. Liquid waste, mixed. Includes any of the previously defined radioactive waste in mixture from 40 CFR, Part 261, RCRA-designated "Hazardous Waste".

a. Be sure it is stored and packaged as in 6a.

10. Blood items. All blood contaminated items must be separated from other waste.

IV. Radioactive Waste Instructions

A. All radioactive wastes must be properly segregated by materials and by nuclides.

B. All sharp objects must be placed in separate "sharps" containers.

C. The Radioactive Material Waste tag (B-1012, page 48) must be filled out COMPLETELY AND ACCURATELY, before the waste will be accepted. The following information is required:

1. Isotope and its activity - both total amount and activity per gram or ml.

2. In addition to checking the appropriate categories, the waste tag must include a description of the wastes.

3. Chemical constituents of the waste must be identified by name. Scintillation cocktails must be identified by brand name or by complete chemical composition. NON-HAZARDOUS AND BIODEGRADABLE COCKTAILS SHOULD BE USED TO REDUCE MIXED WASTE. Contact Radiation Safety Services for information.

4. Project number and RMA number.

5. Tag must be signed and dated.

D. If any material in a waste package is IGNITABLE, HAZARDOUS, TOXIC OR CORROSIVE, as defined by the EPA, the applicable hazard must be listed on the Radioactive Material Waste tag.

E. Radioactive material/waste shall not be moved or stored in areas outside those designated on the particular RMA for that substance. DO NOT PLACE IN HALLWAY FOR PICK-UP.

F. Removal of radioactive waste will be performed as scheduled by the Battelle ES&H Waste Management Group. This will normally be on the 2nd and last working Friday of each month.

V. Storage

A. Prior to pickup by ES&H

1. Package material as specified in Section III, Types of Radioactive Waste.

2. Store waste in secure area as designated on the RMA.

   a. Containers of liquids should be placed in a tray or on absorbent material in case of spills or leakage.

   b. All waste shall be kept out of the walkways.

B. After pickup by ES&H group

1. Solid waste will be taken to the green Sealand container located outside the south side of Building 6 or garages outside Building 15.

2. Liquid waste will be taken either to the Sealand container or garages outside Building 15. Waste will be stored here until processed into 55 gallon drums. This includes scintillation vials.

Battelle
. . . Putting Technology To Work

LIQUID SCINTILLATION MEDIA DE MINIMIS VERIFICATION FORM

NUCLIDE _____ DATE _____

PROJECT NO. _____ RMA # _____

I. Explanation and Qualification of the Exemption

De Minimis classification applies only to licensed material containing 0.05 μCi (microcuries), or less, of H-3 or C-14 per gram of medium used for liquid scintillation counting. (<111,000 dpm per gram of medium)

1. De Minimis materials may be disposed of without regard to their radioactivity.
2. De Minimis provisions do not relieve persons from compliance with radioactive accounting regulations or any other regulations governing management of hazardous materials.

II. Verification of Waste as a De Minimis Quantity for Disposal

Sample Selection

1. Each time you count a group of samples, record the highest sample count. Retain a verified copy of the read-out for the highest sample count to-date in the lab survey record book.
2. When the waste container (original case) is full, use the highest sample count rate for your verification calculation. For bulk samples, ensure that the liquid is well mixed and take three samples for determination of activity. Use the highest sample count rate of the three for your verification calculation. Attach LSC results to De Minimis Form.

Calculation

Record the dpm for the highest activity vial here: (a) _____ dpm

Divide (a) by 2,220,000 dpm/μCi. Record μCi's here: (b) _____ μCi

Record volume of counting medium in the highest activity vial here: (c) _____ ml

Divide (b) by (c) and record value here: (d) _____ μCi/ml
Note: (d) must be less than 0.05 μCi/ml to be qualified as de Minimis.

III. Total Volume and Activity

Record total number of vials in box here (not req. for bulk samples): (e) _____
Note: All vials must contain some volume of counting medium.

Multiply (e) by (c). Record total volume here: (f) _____ ml.
Note: Record total volume for bulk samples here

Multiply (f) by (d). Record total activity here: _____ μCi.

IV. Known Hazard or Pathogen Other Than Radioactivity? yes/no (Circle one) _____
If yes, list hazard and/or cocktail

Note: This includes the scintillation medium and sample.

Submitted by _____ _____
Signature Printed Name

Approved by _____ _____ _____
Radiation Safety Officer Date

RSS-020

Battelle
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DE MINIMIS QUANTITY VERIFICATION
ANIMAL CARCASSES

Date_____

Project #_____

NUCLIDE_____

Carcinogen _____

I. Explanation and Qualification of the Rule.

A. Applies only to animal carcasses containing 0.05 microcuries (μCi), or less, of H-3 or C-14 per gram of animal tissue, averaged over the weight of the entire animal.

1. May be disposed of without regard to their radioactivity.

2. Does not relieve persons from complying with other regulations regarding the disposal of non-radioactive materials.

3. A licensee may not dispose of tissue in a manner that would permit its use either as food for humans or as animal feed.

B. The regulation does not apply to either the radioactive chemicals before they are administrated to the animal, or to feces, urine, or contaminated bedding.

II. Verification for Waste as **De Minimis** Quantity for Disposal.

A. For calculation purposes use the activity remaining in the carcass at the time of sacrifice as verified by research data.

1. Enter that activity in microCuries (μCi) here: (a) _____

B. Enter the weight of the carcass in grams here: (b) _____

C. Divide (a) by (b) and enter here: (c) _____ μCi/g

1. (c) must be less than 0.05 μCi/gm to qualify as De Minimis

III. Known Hazard or Pathogen Other than Radioactivity.

A. _____

IV. Disposal Method.

_____

Submitted by:_____

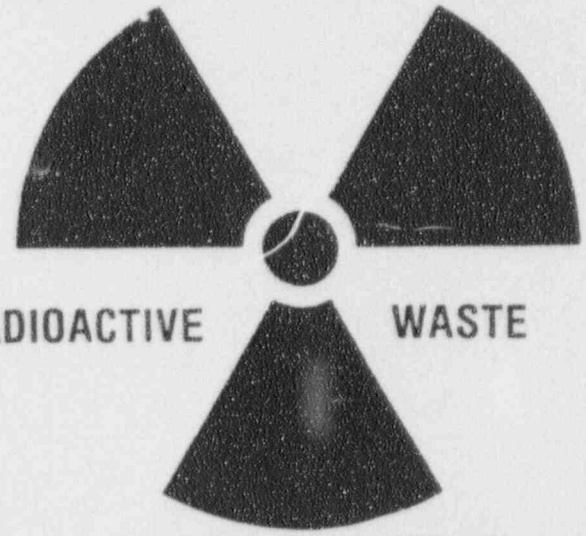
Approved by: _____
Department Health & Safety Officer Date

_____
Radiological Safety Officer Date

RSS-032 (8/93)

RAD MATERIAL TAGS

CAUTION
RADIOACTIVE MATERIAL



ISOTOPE	PHYSICAL STATE	ACTIVITY IN MICROCURIES
	LIQUID	u Ci/ml
	SOLID	u Ci/g
	TOTAL	u Ci

NOTE: SINGLE ISOTOPE PER CONTAINER

WASTE TYPE
- ☐ SOLID ☐ SOLVENT
- ☐ AQUEOUS LIQUID (WATER ONLY)
- ☐ DE MINIMIS SCINTILLATION FLUID
- ☐ DE MINIMIS BIOLOGICAL (FROZEN)
- ☐ SCINTILLATION FLUID, NOT DE MINIMIS
- ☐ BIOLOGICAL (FROZEN), NOT DE MINIMIS
- ☐ OTHER _____

CONTINUE ON REVERSE

CHEMICAL AND PHYSICAL DESCRIPTION OF
(INCLUDE/ BREAKDOWN, IF KNOWN)

A. WHOLE WASTE B. RADIOACTIVE MATERIAL(S)
C. NON-RADIOACTIVE MATERIAL(S)

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

CONTAMINATION DATA

SURFACE CONTAMINATION ON MATERIAL
Beta-Gamma _____ DPM/100 cm2
Alpha _____ DPM/100 cm2

RADIATION DATA

SURFACE DOSE RATE _____ mrem/hr

PRINT NAME _____

ROOM NO. _____ PICK UP DATE _____

SECTION NO. _____ PROJECT NO. _____

SIGNATURE _____

B-1012

Ionizing Radiation-Producing Machines

I. Purpose

Several facilities at Battelle use ionizing radiation-producing machines such as medical and veterinary X-ray machines, research X-ray units, X-ray diffraction units, and electron microscopes. Improper use or inadequate control of these sources could result in overexposure of operating personnel, patients, and others to ionizing radiation. To reduce the amount of radiation exposure contributed by these sources and to ensure the safety of Battelle staff, the radiation protection procedures for ionizing radiation-producing machines listed below must be followed.

II. Procedures for Purchase

A. All purchase requests and other orders for radiation-producing machines require the approval of the Radiological Safety Officer.

B. Purchase requisitions must first be sent to Radiation Safety Services. The purpose of this procedure is to ensure that Radiation Safety Services staff is notified of all new radiation-producing machines at Battelle. A Radiation Safety Services representative will then make certain that the machine is properly registered and that the facility meets the requirements for the radiation protection of personnel.

C. Radiation Safety Services must be notified when the machine is received and a Radiation Safety Services staff member must make a radiation survey of the machine before it is placed into use.

III. Registration and Authorization for Use of Radiation-Producing Machines

A. All radiation-producing machines must be registered at the time of purchase and every two years thereafter with Radiation Safety Services. Radiation Safety Services will send registration forms to an individual or department at the time the purchase of a machine is requested and at time of re-registration. (See form RSS-030, page 53).

B. Approval will be based on the pre-operational radiation protection survey conducted by a Radiation Safety Services representative and will serve as the authorization for use. The authorization will extend for the two-year period of registration for the radiation-producing machine, after which the machine must be re-registered.

IV. Changes in Use

Any change in the use, design, or location of an ionizing radiation-producing machine must be approved by the Radiological Safety Officer. Such changes may require amendment of the registration form, along with a new radiation survey of the machine.

V. Disposal or Transfer

If a radiation-producing machine is to be sold, traded, transferred, or disposed of, Radiation Safety Services must be notified. Radiation Safety Services must be provided with information relating to the disposal or transfer prior to such action to assure compliance with State of Ohio regulations.

VI. General Requirements for Radiation-Producing Machines

A. Unless previously determined through survey data or exposure history, all personnel associated with the use of ionizing radiation-producing machines must wear personnel radiation monitors. Monitors are to be obtained through and worn in accordance with the requirements of Radiation Safety Services. The individual responsible for the machine must ensure that all personnel associated with the use of the machine obtain the necessary radiation dosimeters from Radiation Safety Services.

B. Individuals are also required to satisfy State of Ohio regulations pertaining to employee training. This requirement will be met by attending Radiation Safety Services supplied training classes.

C. Except for medical X-ray machines, each area where radiation-producing machines are used must be posted with an appropriate radiation warning sign. Rooms that are used for medical diagnosis should have a warning light that indicates *"X-Ray On"* to alert personnel who may inadvertently enter a room during operation of the machine.

D. A Radiation Safety Services representative will make an annual radiation survey of all radiation-producing machines, unless otherwise specified.

E. All plans for new and remodeled facilities associated with radiation producing machines must be reviewed by a Radiation Safety Services representative during the preliminary planning stages. Requirements specified by the Radiological Safety Officer must be followed.

F. A Radiation Safety Services staff member must make a radiation survey of all new and remodeled facilities before use.

VII. X-ray Diffraction

Open beam X-ray diffraction units can be hazardous because of the very high primary beam exposure rates (several 10,000 R/minute) at the X-ray tube ports. Serious damage can result to an individual's eyes and skin, even if exposed to these intense radiation levels for a very short period of time. Extreme caution must be exercised in the use of X-ray diffraction equipment. The following are requirements for safe use of X-ray diffraction units:

A. Appropriate radiation shielding (as specified by Radiation Safety Services) must be installed on each X-ray diffraction unit. These shields shall be interlocked to prevent radiation exposure to personnel when the shield is removed or opened.

B. All beam shutter mechanisms must be interlocked to prevent operation if the shutter is not properly closed.

C. The authorized user of X-ray diffraction equipment is responsible for ensuring that all personnel operating the equipment understand the radiation exposure potential and are properly trained in operating procedures required for safe operation of equipment.

D. All X-ray diffraction units and use areas must be labeled with appropriate radiation caution signs. Operational radiation warning lights are also required.

E. All personnel associated with the use of X-ray diffraction equipment must be assigned appropriate personal radiation monitors.

F. Radiation Safety Services must be notified immediately in the event of a failure in any radiation protection system or of suspected personnel radiation exposure.

VIII. Medical X-ray Machines

To control the radiation exposure from medical X-ray sources and maintain radiation exposure to individuals as low as reasonably achievable, authorized users and operating personnel shall comply with the following procedures:

A. All personnel must wear the required personnel radiation monitors assigned to them. The body badge is to be worn *under* the lead apron. NOTE: Do not wear the badge on the lead apron and do NOT wear the badge home.

B. Any employee who is required to be in the room during operation of the X-ray unit must wear a protective lead apron (recommended thickness 0.5 mm lead equivalent, minimum 0.25 mm lead equivalent) or stand behind a protective barrier.

C. Any individual who holds a patient during X-ray examination must wear a lead apron and lead gloves, and must stand clear of the primary beam. Whenever possible, no

individual shall, as part of his or her job, regularly hold patients during X-ray examinations.

D. Lead aprons, gloves, and other protective devices should be inspected once every six months to detect cracks and breaks in the shielding. These devices should be replaced immediately if defects are detected.

E. Protective shielding for patient gonadal areas must be used for all examinations where the primary beam will include or is near the patient gonadal area, except when the physician determines that this will interfere with the X-ray examination. With the currently available male gonadal shields, it should be possible to provide testicular shielding for males during all X-ray examinations requiring gonadal shielding. In the case of pregnant women protective shielding must be provided for the fetus, except when the physician determines that such shielding will interfere with the X-ray examination. Gonadal and fetal shields should be a minimum of 0.5 mm lead equivalent.

F. All X-ray machines must have properly installed and approved primary beam collimation devices, and the operator must collimate the primary radiation beam to include only that area required in the examination.

G. Any individual operating portable X-ray machines must wear a lead apron and stand at least six feet from the radiation field during the exposure. The operator must make certain that all personnel stay clear of the primary beam.

IX. Veterinary X-ray Units

The same requirements listed for medical X-ray units, with the exception of protective shielding for the patient, apply to the use of veterinary X-ray units.

X. Electron Microscopes

A. The radiation exposure limits for electron microscopes must comply with the federal standards (less than 0.5 mR/hour at 5 cm from the surface).

B. Unless specified by the Radiological Safety Officer, personal radiation monitors will not be required for personnel using electron microscopes.

XI. Research X-ray Machines

The same requirements that are listed for X-ray diffraction units will apply to the use of research X-ray machines.

IONIZING RADIATION-PRODUCING MACHINE REGISTRATION FORM

This form must be completed and forwarded to the Radiation Safety Services, Room 1433.

NAME OF APPLICANT:_____ TITLE:_____

DEPARTMENT:_____PHONE NO._____

1. Name, training and experience of individuals who will operate the radiation-producing machines (attach additional sheets if needed):

Name	Type of Training and/or Experience	Type of Machine Used

2. Description of radiation-producing machines (use additional sheets if needed).

Type of Machine	Manufacturer	Model #	Serial #	Maximum		Location	Machine Purpose
				mA	kVp		

3. Describe the radiation protection precautions followed in the use of the radiation-producing machines. Give sufficient information on the methods and/or control devices used to prevent accidental or unnecessary radiation exposure of personnel, the general public, and patients (if applicable).

_____

_____

_____

To the best of my knowledge this application is complete and accurate.

DATE:_____ _____APPLICANT'S SIGNATURE:_____

A representative of the Radiation Safety Services has made a radiation protection survey of the above listed radiation-producing machines, and has discussed with the applicant the radiation protection requirements necessary for use of the machines. If there are any special conditions on the use of the machines, they will be attached to this form.

DATE:_____Health Physicist:_____

You have been authorized for use of the radiation-producing machines listed above under registration number_____

This registration expires on _____. The applicant is responsible for re-registration of the machines prior to the expiration date.

RSS-030

Radiological Emergencies

If a radiological accident occurs, the first responder must consider the health and safety of the personnel involved as the primary concern taking precedence over the radiological concerns. Internal uptake is most commonly caused by radioactive spills or needle punctures. Accidental external exposure is most commonly caused by lost radioactive sources or malfunctions involving high-level radiation equipment.

It is important to call Radiation Safety Services (RSS) immediately in an emergency situation, because as these personnel are trained to determine the extent of radiation exposure that may result from a radiological emergency. Call the Control Center at **4-4444** or **4-5435** for West Jefferson.

When reporting an emergency it is important to remain on the line and give as much information about the situation as possible. The following is information that will be requested:

- your name and location
- a phone number where you can be reached
- the nature of the accident and if medical assistance is required
- the radionuclide involved.

The following are considered to be radiological emergencies:

- Spills
- Personnel Contamination
- Needle Punctures
- Lost Sources
- Lost Dosimetry
- Equipment Malfunction
- Loss of Material Control.

I. Spills

Spills can either be categorized as **major spills** or **minor spills** depending upon the quantity or radiotoxicity of the material involved. Major spills are those involving significant exposure, potential minor spills are those involving a minimal exposure hazard. The Spill Hazard Guidelines (page 57) is a table which can be used as a guide for determining the extent of a potential spill hazard. This guide should be referred to **before** starting work with the isotope so the correct response can be made in the event of a spill. The guidelines given are general guidelines to ensure the radiation protection of workers. The chemical hazards of the spill must also be considered in any spill response. Chemical spill guidelines are not covered by this document.

For **major spills**:

- Stop the spill if it is possible to do so without danger and,
- Warn all personnel in the area, restrict access to the spill, and **call RSS immediately**.
- Cover liquid spills with absorbent material.
- Cover dry spills with damp adsorbents taking care to ensure that the spilled material is not spread in the process.
- Secure any systems still operating which could contribute to the spread of contamination.
- **DO NOT ATTEMPT TO DECONTAMINATE THE AREA UNTIL RSS ARRIVES.**
- Frisk and start decontamination on any personnel who may have become contaminated.
- **Do not** resume work in the area until RSS has performed a survey and released the area.

For **minor spills**:

- Stop the spill, warn others in the area and restrict access.
- Decontaminate area to below 100 dpm/100 cm^2.
- Notify RSS so that a verification survey may be performed.

II. Personnel Contamination

If you or a co-worker becomes contaminated, contact RSS immediately and start the decontamination process. Wash contaminated area with soap and tepid water. Survey the area and if the area is above 1000 dpm/100 cm^2 (100 cpm above background) repeat the previous step. Resurvey; if still contaminated, wait for RSS staff to arrive. **DO NOT LEAVE THE AREA UNLESS REQUIRED FOR PERSONAL SAFETY**. If you must leave the area take the most direct path to a phone and warn others to stay clear of the path until it has been surveyed and released by RSS. Follow the directions of RSS regarding any further decontamination procedures and/or bioassay instructions.

NOTE: If using compounds that are reactive to water, be sure to have the neutralizing agent available in case of skin contamination.

III. Needle Punctures

Take immediate first aid actions for the chemical injected. When reporting the accident be sure to include any information regarding any required medical care. Contact RSS immediately and give them information on the isotope and activity. Follow the directions of RSS regarding transport of the injured person and bioassay instructions.

IV. Lost Sources

When a source is discovered to be missing, contact RSS immediately and report the isotope, activity, and the last known location. If the known dose rate at 30 centimeters is greater than **2 mR/hr**, evacuate any personnel that do not have a TLD and limit access to the affected area. If a dose rate instrument is available, perform a radiation survey in the affected areas to attempt to locate the source. **If found, do not handle the source until RSS arrives.**

If the source is known to be greater than **5 mR/hr at 30 centimeters** evacuate **all** personnel and limit access until RSS arrives. **DO NOT ATTEMPT TO LOCATE THE SOURCE.** Follow the directions of RSS regarding subsequent transportation and storage of the source.

V. Lost Dosimetry

As soon as you discover you have lost your TLD you must **EXIT THE AREA IMMEDIATELY** and contact RSS. Do not enter any restricted areas until a dose evaluation has been performed and you have received a new TLD.

VI. Equipment Malfunction

Immediately report all malfunctions of any equipment capable of producing 2 mR/hr at any external surface of the equipment and restrict access to all non-badged personnel. If the recorded measured dose rate 30 centimeters from the equipment is greater than 5 mR/hr, evacuate **all** personnel from the affected areas. **DO NOT ATTEMPT TO OPERATE THE EQUIPMENT UNTIL RSS ARRIVES.** Follow all directions of RSS regarding radiological controls required while operating or repairing malfunctioning equipment.

VII. Uncontrolled Radioactive Material In Unrestricted Areas

Restrict access to the material and contact RSS. If the dose rate is unknown, keep all personnel as far away as possible. **DO NOT APPROACH THE MATERIAL UNTIL RSS ARRIVES.** If a dose rate instrument is available, perform a radiation survey at the boundary of the affected area to verify that the dose rate at the boundary is less than 2 mR/hr. If the dose rate is greater than or equal to 2 mR/hr, move the established boundary out until the dose rate is less than 2 mr/hr. Do not allow access to the affected area. Follow RSS directions concerning access restrictions and recovery of the material.

A written report of all radiological emergencies must be prepared listing all involved individuals and actions taken. This report must be filed with the RSO within five (5) working days.

SPILL HAZARD GUIDELINES

Low Hazard — Above **1 mCi**, treat as major spill

H-3	Be-7	C-14	F-18	U-238	natural thorium
natural uranium		noble gases			

Medium Hazard — Above **100 μCi**, treat as major spill

Na-24*	P-32	S-35	K-42*	Cr-51	Fe-59*
Rn-220	Rn-222*	U-235			

High Hazard — Above **10 μCi**, treat as major spill

Na-22*	Ca-45	Co-60*	Sr-90	I-125*	I-129
I-131*	Cs-137*	Ra-224	U-233		

Very High Hazard — Above **1 μCi**, treat as major spill

Po-210	Ra-226*	Th-228	Ra-228*	Pu-238	Pu-239
Pu-240	Am-241*				

* indicates significant gamma emitter

If a major spill occurs:

Stop the spill -	Cover the spill and attempt to confine it to the smallest possible area.
Warn others -	Warn others in the area that a spill has occurred. Call the Control Center at **4-4444** immediately.
Isolate the area -	Secure access to the affected area until the spill has been cleaned up.
Mininize exposure -	Once the spill is covered and/or confined, stay out of the area unless further action is required.
Secure ventilation -	If possible, secure ventilation to the affected area. If not, attempt to redirect ventilation away from the area to minimize the spread of contamination.

APPENDIX A

SPECIFIC ISOTOPE DATA

APPENDIX A

SPECIFIC ISOTOPE DATA

Appendix B is a table of some common radioactive isotopes and their categories which gives information on the half life, ingestion Annual Limit on Intake (ALI), and associated dose rates. Routine contamination surveys should be done according to the amount of the unsealed source being used. The section on survey requirements contains a table of recommended survey frequencies. Except for tritium, personnel frisking should be done after each use. All volatile compounds should be handled inside a ventilation hood. Protective clothing will be determined by the RSO per RMA.

Carbon-14 **Half-life: 5730 years** **Max. beta range in air: 8.6 inches**

C-14 is a low energy beta emitter and primarily an internal hazard. It has very low penetrating ability so no external dosimetry is required. Bioassay in the form of urine samples should be done in the case of suspected intake, and at the termination of the project or employment. Special consideration should be given to organic compounds as these compounds have the potential to be absorbed through gloves. Care should be taken not to generate CO_2 which could be inhaled.

Tritium **Half-life: 12.28 years** **Max. beta range in air: 0.19 inches**

H-3 is a low energy beta emitter and primarily an internal hazard. It has very low penetrating ability so no external dosimetry is required. Bioassay in the form of urine samples should be done in the case of suspected intake, and at the termination of the project or employment. H-3 is an absorption hazard; appropriate gloves for the compounds being used should be worn. H-3, because of its low beta energy cannot be detected by portable instruments so special care must be taken to ensure the work area is kept clean and tidy. Routine surveys for the quantities being used should be done using a Liquid Scintillation Counter. The ALI for DNA precursors is lower than for other compounds because they are regarded as more toxic. ICRP 30 (available at RSS) contains the information on those limits.

Sulphur-35 **Half-life: 87.4 days** **Max. beta range in air: 9.6 inches**

S-35 is a low energy beta emitter and primarily an internal hazard. It has very low penetration ability so no external dosimetry is required. Bioassay in the form of urine samples should be done in the case of suspected intake, and at the termination of the project or employment. S-35 in organic compounds are often strongly retained and no limits of exposure have been set for them. Care also needs to be taken not to generate sulphur dioxide or hydrogen sulphide which could be inhaled. S-35, having the approximate energy of C-14, can be detected using portable instruments.

Phosphorus-32 Half-life: 14.3 days Max. beta range in air: 20 feet

P-32 is a very high energy beta emitter and both an internal and external hazard. Because of its high penetrating ability external dosimetry must be used. A bioassay program in the form of urine samples will be specified by the RSO per the RMA. Emphasis should be on control of doses to extremities and prevention of intake. Care should be taken to avoid direct handling of containers, as even very short contact periods of μCi quantities can cause considerable exposures. The dose rate at the open end of a vial containing 1 mCi of P-32 in 1 ml of liquid is approximately 26 rem/hour. Generation of ***bremsstrahlung*** should be avoided by using plexiglass or equivalent materials for shielding. For mCi quantities, lead shielding should be used in addition to the plexiglass to attenuate the secondary radiation being produced. Mock-ups or trial runs should be done prior to the actual operation to prohibit unnecessary exposure. Operations should be done with 2 people present. **NEVER WORK OVER AN OPEN CONTAINER OF P-32.** Special protection for the lens of the eyes should be used, eg., face shields. All spills should be considered major and RSS contacted immediately upon isolating the area. Personnel decontamination should begin immediately if necessary. Gases or volatile form compounds should be handled inside a ventilation hood with a HEPA filter. When in actual use personnel should check hands frequently for contamination. Radioactive waste should be dose rated frequently to ensure proper posting of the area.

Sodium-22 Half-life: 2.6 years Max. beta range in air: 56 inches

Na-22 is a beta and gamma emitter causing it to be both an internal and external hazard. Personnel dosimetry should include TLD's for external monitoring and urine samples for internal monitoring. Near an unshielded Na-22 source, dose rates due to beta radiation (skin dose) can be much higher than dose rates due to gamma radiation. **NEVER WORK OVER OPEN CONTAINERS OF NA-22.** Plexiglass, to inhibit brehmsstrahlung radiation, and lead outside the plexiglass to absorb the gamma radiation should be used for shielding. Remote handling devices should be used to manipulate vials or other containers. Operations shall be done with 2 persons present. All spills should be considered major and RSS should be contacted immediately upon isolating the area. Personnel should immediately begin skin decontamination if necessary. When in use, personnel should frisk hands frequently and change the outer pair of gloves as needed. Rad waste should be monitored for dose rates to ensure the posting is adequate.

APPENDIX B

RADIONUCLIDE CATEGORIES AND DATA

RADIONUCLIDE CATEGORIES AND DATA
(For data on radionuclides not listed below, contact the RSO)

Nuclide	Half-life	Ingestion ALI (mCi)	Dose Rates (mrem/hour): Penetrating At 1 meter from 1 mCi	Dose Rates (mrem/hour): Skin dose at 0.07 mm per $\mu Ci/cm^2$
"LO-BETAS" - low-energy beta or electron emitters with negligible external exposure potential and ALI's ≥ 1 millicurie.				
H-3	12 yrs	80.	0.	
C-14	5730 yrs	2.	0.	1200
S-35	**87 days**	6.	0.	1300
Ca-45	165 days	2.	0.	
Cr-51	**28 days**	40.*	0.02	
Ni-63	100 yrs	9.	0.	
"HI-BETAS" - high-energy beta emitters with negligible gamma emission but capable of significant *bremsstrahlung* production if not properly shielded. Emphasis is on control of doses to extremities and prevention of intake.				
P-32	**14.3 days**	0.6	0.	8900
Sr-90	28.6 yrs.	0.03	0.	
"IODINES" - radioiodines are treated as a separate category for exposure evaluation. Emphasis is on prevention of intake by ingestion or inhalation.				
I-125	**60 days**	0.04	0.07	
I-129	$6x10^9$ yrs	0.005	0.13	
I-131	**8 days**	0.03	0.22	6300
"GASES" - noble gases present minimal exposure potential or waste disposal problems.				
Kr-85	10.7 yrs	NA	0.	
"NATURAL" - naturally occurring nuclides, primarily alpha emitters. Emphasis is on prevention of intake by ingestion or inhalation.				
Th-232 (nat)	$14x10^9$ yrs	0.0007	0.	
U-238 (nat)	$4.5x10^9$ yrs	0.2	0.	

Nuclide	Half-Life	Ingestion ALI (mCi)	Dose Rates (mrem/hour):	
			Penetrating at 1 meter from 1 mCi	Skin dose at 0.07 mm per $\mu Ci/cm^2$
"GAMMAS" - gamma emitters with ALI ≥ 1 millicurie; emphasis is on external exposure control and monitoring.				
Mn-54	312 days	2.	0.51	
Co-57	271 days	4.*	0.15	290
Sr-85	64.8 days	3.*	0.75	55
I-123	0.542 days	3.	0.28	
Pb-203	2.2 days	5.	0.68	
ALL OTHER NUCLIDES is not included in one of the above groups are assumed to have significant potentials for both external and internal exposures and must be evaluated individually.				
Na-22	2.6 yrs	0.4	1.33	7200
Fe-59	44.6 days	0.8	0.66	4600
Co-60	5.27 yrs	0.2	1.37	
Ir-192	74 days	0.9	0.59	
Hg-203	47 days	0.5	0.25	

* The ALI is not applicable to microspheres, which are highly insoluble particles, typically greater than 0.01 mm diameter. They require external exposure control and monitoring, but are not readily absorbed from the gastrointestinal tract. If inhaled, because of their size, they are most likely to be deposited in the upper respiratory tract from which they would be cleared by the mucous transport and swallowed.

APPENDIX C

QUANTITIES OF RADIOACTIVE MATERIAL REQUIRING LABELING

QUANTITIES OF RADIOACTIVE MATERIAL REQUIRING LABELING

MATERIAL	MICROCURIES
Americium-241	.0001
Carbon-14	100
Cesium-137	1
Cobalt-60	0.1
Hydrogen-3	100
Krypton-85	100
Nickel-63	10
Phosphorous-32	1
Polonium-210	.01
Radium-226	.01
Sodium-22	1
Sulphur-35	10

NOTE: For any isotopes not listed contact Radiation Safety Services, 4-7676.

APPENDIX D

GLOSSARY OF NUCLEAR TERMS

GLOSSARY OF NUCLEAR TERMS

Absorbed Dose (10 CFR 20)

Means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Accountability (ANSI N1.1-1976)

Quantitative accounting for nuclear material inventories and transfers through a system of measurements, records, and reports.

Act (10 CFR 20)

Means the Atomic Energy Act of 1954 (42 U.S.C. 2011 et. seq.), as amended.

Activity (10 CFR 20)

The rate of disintegration (transformation), or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

ALARA (acronym for "As Low as is Reasonably Achievable") (10 CFR 20)

Means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part 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 benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Alpha Particle (BEIR V-1990)

Two neutrons and two protons bound as a single particle that is emitted from the nucleus of certain radioactive isotopes in the process of decay or disintegration.

Annual Effective Dose Equivalent (10 CFR 20)

The effective dose equivalent received in a year, expressed in REM.

Annual Limit on Intake (ALI) (10 CFR 20)

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 of intake of a given radionuclide in a year by the reference man which 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 selected radionuclides are given in Table 1, Columns 1 and 2 to 10 CFR 20.1001-20.2401).

Background Radiation (10 CFR 20)

Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devises. Background radiation does

not include radiation from source, by-product, or special nuclear materials regulated by the Commission.

Becquerel (Bq) (NCRP 83-1985)

SI unit of activity. 1 Bq = 1 s^{-1}. (Read as 1 nuclear transition per second.)

Beta Particle (ANSI N1.1-1976)

An electron, of either positive or negative charge, which has been emitted by an atomic nucleus or neutron in a nuclear transformation.

Bioassay (Radiobioassay) (10 CFR 20)

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.

Bremsstrahlung (BEIR III-1980)

Secondary photon radiation produced by deceleration of charged particles passing through matter.

By-product Material (10 CFR 20)

(1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and

(2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "by-product material" within this definition. *(Examples would be C-14, H-3, P-32, etc.)*

Check Source (ANSI N42.15-1980)

A radioactive source, not necessarily calibrated, which is used to confirm the continuing satisfactory operation of an instrument.

Collective Dose (10 CFR 20)

The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Committed Dose Equivalent (HT,50) (10 CFR 20)

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.

Committed Effective Dose Equivalent (HE,50) (10 CFR 20)

The sum of the products of weighing factors applicable to each of the body organs or tissues which are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \sum w_T H_{T,50}$).

Contamination (radioactive) (NCRP 65-1980)

A radioactive substance dispersed in materials or places where it is undesirable.

Controlled Area (10 CFR 20)

An area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. *At Battelle, the Controlled Area begins at the key-card access to any building.*

Curie (BEIR IV-1988)

A unit of activity equal to 3.7×10^{10} disintegrations/second.

Declared Pregnant Woman (10 CFR 20)

A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Deep-dose Equivalent (Hd) (10 CFR 20)

Which applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

DeMinimis (10 CFR 20)

(a) A licensee may dispose of the following licensed material as if it were not radioactive:

(1) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of medium used for liquid scintillation counting; and

(2) 0.05 microcurie (1.85 kBq), or less, of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

(b) A licensee may not dispose of tissue under paragraph (a)(2) of this section in a manner that would permit its use either as food for humans or as animal feed.

(c) The licensee shall maintain records in accordance with 10 CFR 20.2108.

Derived Air Concentration (DAC) (10 CFR 20)

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.

Derived Air Concentration-hour (DAC-hour) (10 CFR 20)

The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rems (0.05 Sv).

Dose or Radiation Dose (10 CFR 20)

A generic term which means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose Equivalent (HT) (10 CFR 20)

The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Effective Dose Equivalent (HE) (10 CFR 20)

The sum of the products of the dose equivalent to the organ or tissue (HT) and the weighing factors (wT) applicable to each of the body organic or tissues which are irradiated ($HE = \sum wTHT$).

Entrance or Access Point (10 CFR 20)

Means any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry irrespective of their intended use.

Exposure (10 CFR 20)

Means being exposed to ionizing radiation or to radioactive material.

External Dose (10 CFR 20)

That portion of the dose equivalent received from radiation sources outside of the body.

Extremities (10 CFR 20)

Means hand, elbow, arm below the elbow, foot, knee, and leg below the knee.

Eye Dose Equivalent (10 CFR 20)

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 cm (300 mg/cm^2).

Gamma Radiation (ANSI N1.1-1976)

Electromagnetic radiation emitted in the process of nuclear transition of particle annihilation.

Gray (Gy) (10 CFR 20)

The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule/kilogram (100 rads).

High Efficiency Particulate Air (HEPA) Filter (ANSI N303-1978)

A gas filter having a fibrous medium that produces a particle-removal efficiency of at least 99.97% for 0.3-micron-diameter monodisperse dioctylphthalate (DOP) particles, on a count basis, in accordance with American Association for Contamination Control Standard for HEPA Filters, AACC CS-1.

High Radiation Area (10 CFR 20)

An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 cm from the radiation sources or from any surface which the radiation penetrates.

Individual Monitoring Devices (individual monitoring equipment) (10 CFR 20)

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.

Internal Dose (10 CFR 20)

Means that portion of the dose equivalent received from radioactive material taken into the body.

Isotope (NCPR 48-1976)

One of several nuclides of the same element, having the same nuclear charge but different nuclear mass.

Licensed Material (10 CFR 20)

Means source material, special nuclear material, or by-product material received, possessed, used, or transferred under a general or specific license issued by the Commission.

Limits (Dose Limits) (10 CFR 20)

The permissible upper bounds of radiation doses.

Lost or Missing Licensed Material (10 CFR 20)

Means licensed material whose location is unknown. It includes material which has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

Member of the Public (10 CFR 20)

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 received an occupational dose.

Monitoring (Radiation Monitoring, Radiation Protection Monitoring) (10 CFR 20)

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.

Non-stochastic Effect (10 CFR 20)

Means health effects, the severity of which varies with the dose, and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a non-stochastic effect.

NRC (10 CFR 20)

Means the Nuclear Regulatory Commission or its duly authorized representatives.

Occupational Dose (10 CFR 20)

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 natural background, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Quality Factor (Q) (10 CFR 20)

Means the modifying factor (listed in Tables 1004(b).1 and 1004(b).2 of 10 CFR 20.1004) that is used to derive dose equivalent from absorbed dose.

Quarter (10 CFR 20)

Means a period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Rad (10 CFR 20)

The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).

Radiation (Ionizing Radiation) (10 CFR 20)

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 part, does not include non-ionizing radiation, such as sound, radio, or microwaves, or visible, infrared, or ultraviolet light.

Radiation Area (10 CFR 20)

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 cm from the radiation source or from any surface which the radiation penetrates.

Radioactive Material (NBS 61-1955)

Any material, solid, liquid, or gas that emits radiation spontaneously.

Radiological Safety Officer(RSO) (NBS 54-1954)

Person responsible for radiological safety in connection with use, handling, and storage of radioactive materials. It is his duty to make certain that all procedures are carried out in compliance with established rules, including regulations contained in this Handbook.

Rem (10 CFR 20)

The special unit of dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sieverts).

Respiratory Protective Device (10 CFR 20)

Means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

Restricted Area (10 CFR 20)

An area, access to which is limited by the licensee for the purpose of protecting 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. *At Battelle, all access points to a Restricted Area are posted with the standard radiation "trefoil" symbol.*

Sanitary Sewerage (10 CFR 20)

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 (ANSI N1.1-1976)

A radioactive source sealed in a container or having a bonded cover, the container or cover being strong enough to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed.

Shallow Dose Equivalent (Hs) (10 CFR 20)

Applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm^2) averaged over an area of 1 cm^2.

Sievert (10 CFR 20)

The SI unit of dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

Site Boundary (10 CFR 20)

Means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Source (NCRP 48-1976)

A discrete amount of radioactive material, or the part of the x-ray tube from which the rays are emitted.

Source Material (10 CFR 20)

Means uranium or thorium, or any combination thereof, in any physical or chemical form: or ores which contain by weight one-twentieth of one percent (0.05%) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material.

Special Nuclear Material (10 CFR 20)

Means: plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or any material artificially enriched by any of the foregoing but does not include source material.

Stochastic Effects (10 CFR 20)

Health effects which occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without a threshold. Hereditary effects and cancer incidents are examples of stochastic effects.

Total Effective Dose Equivalent (TEDE) (10 CFR 20)

The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted Area (10 CFR 20)

Means an area, access to which is neither limited nor controlled by the licensee.

Very High Radiation Area (10 CFR 20)

Means an area, accessible to individuals, in which radiation levels could not 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 which the radiation penetrates. [Note: At very high doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts).]

Week (10 CFR 20)

Means 7 consecutive days starting on Sunday.

Weighing Factor, wT, for an organ or tissue (T) (10 CFR 20)

The proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of wT are:

ORGAN DOSE WEIGHING FACTORS	
Organ or Tissue	**wT**
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 [1]
Whole Body	1.00 [2]

[1] 0.30 results from 0.06 for each of 5 "remainder organs" (excluding the skin and the lens of the eye) that receive the highest doses.
[2] For the purpose of weighing the external whole body dose (for adding it to the internal dose), a single weighing factor, wT = 1.0, has been specified. The use of other weighing factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Whole Body (10 CFR 20)

Means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

X Ray (NCRP 65-1980)

A penetrating form of electromagnetic radiation emitted either when the inner orbital electrons of an excited atom return to their normal state or when a metal target is bombarded with high-speed electrons. X rays are always non-nuclear in origin.

APPENDIX E

EXCERPTS FROM THE RADIOLOGICAL SAFETY COMMITTEE CHARTER

Appendix E

Criteria for RSC Review

The determination whether RSC review of a particular experiment is or is not necessary is based upon the potential radiological hazard associated with that work. The hazards with which the RSC is concerned are those affecting Battelle staff and property, public persons, private and public property, and the environment. Since the primary responsibility for operational safety rests with the cognizant line manager, the experimenter or his manager is responsible for doing a hazards analysis of sufficient depth to determine if review is required. If a review is required, it is the responsibility of the applicant to demonstrate to the RSC that he has completely identified the hazards and designed adequate controls for the hazards.

Guidelines are provided in the following section to identify those activities which require RSC review. In some cases there may be some questions whether review is mandatory, but review may be considered advisable. The cognizant line manager, division vice president or the RSO may request that an RSC review be performed.

A. Mandatory RSC Review - Review by the RSC is required where:

(1) Radionuclides are proposed to be handled in unsealed form in greater than 200 millicurie quantities.

(2) Large quantities (Curie quantities) of radioactive materials are proposed to be used as sealed sources.

(3) Highly reactive, flammable, explosive, toxic or corrosive materials are proposed to be used which are also radioactive or are to be used in conjunction with radioactive materials.

(4) High pressure systems or other high energy systems are to be used in conjunction with radioactive materials.

(5) Plans for construction or significant alterations of a facility or equipment are proposed for experiments that require review. The plans must be reviewed before construction or alteration is begun. A construction engineer may be asked to sit on the review committee as a consultant at the discretion of the Chairperson. The facility design must include consideration of possible radioactive release by natural forces and external threats.

(6) New, untried, or unusual processes or procedures or significant changes in existing processes or procedures are proposed in experiments that require review. (This includes the beginning of operations in a new or significantly altered facility or with new or significantly altered equipment.)

(7) In experiments where new or inexperienced researchers and staff members will be involved. The request for review must include a discussion of how the personnel will be provided orientation and training before performing hands-on work.

(8) There is a real potential for occurrence of any of the situations listed below.

(a) Review is required where a hazards analysis reveals a substantial potential for any of the following:

(1) The release of radioactive powders, dusts, fumes, or mists, greater than 1/10 Derived Air Concentration Values, into laboratory air where staff are not protected or the unplanned escape of radioactive materials into the environment.

(2) The use of formation of pyrophoric, flammable, explosive or highly corrosive substances in combination with radioactive materials.

(3) The use or development of high pressures in combination with radioactive materials.

(4) An exposure of greater than 50% of annual limit to a staff member internally or externally.

(5) Exposure in excess of minimal levels to persons of the general public or persons not considered radiation workers.

(b) In review of proposed operations, special consideration should be given to:

(1) The potential for inadvertent release of radioactive materials to the environment or into the work area by conditions or forces associated with the operation or by natural forces.

(2) The potential for fire, explosion, pressures exceeding containment capability, burnout of filters, plugging filters by dense smoke and loss of ventilation by loss of power.

(3) The capability of the facility or equipment proposed to be used to function as appropriate; maintenance of equipment.

(4) Radioactive wastes that may be produced and the arrangements to dispose of the wastes.

(5) The measurement and control of effluents.

(6) Mixtures of radioactive and certain EPA regulated wastes which may be exceedingly difficult to dispose.

(6) Mixtures of radioactive and certain EPA regulated wastes which may be exceedingly difficult to dispose.

Requesting RSC Review:

Requests for RSC review of a use will be submitted by the cognizant line manager (or by the investigator, with approval of the cognizant line manager). Requests for review will be made by completing an RMA and submitting the form to the RSO.

The Review Request - The review request must include the following elements:

(1) A general description of the project.

(2) Description of operations, processes, and procedures.

(3) Time schedule of the project.

(4) Facilities and equipment to the used.

(5) Identification of personnel who will direct and perform the work with their experience and training.

(6) Careful and thorough hazards analysis.

(7) Precautions to be taken to prevent potential safety problems.

(8) Contingency plans for emergencies.

(9) Health physics procedures, considerations and/or commitments.

(10) Discussion of radioactive scrap and waste that will be generated and the specific arrangements that have been made for disposition of the scrap and waste.

(11) Discussion of the disposition of contaminated equipment and the facility on completion of the project.

(12) The RMA will be attached to provide the other general information not described above.

APPENDIX D

RADIATION PROTECTION PROGRAM FOR THE BCLDP

Rev. 2/July 2, 1992

Radiation Protection Program for the Battelle Columbus Laboratories Decommissioning Project

July 1992

Battelle Columbus Laboratories
Decommissioning Project
Columbus, Ohio 43201

Radiation Protection Program for the
Battelle Columbus Laboratories
Decommissioning Project
Revision 2; July 2, 1992

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Abbreviations and Acronyms

ALARA	as low as reasonably achievable
ALI	annual limit on intake
BCLDP	Battelle Columbus Laboratories Decommissioning Project
CAM	continuous air monitor
mCi	millicurie
cm	centimeter
cpm	counts per minute
DAC	derived air concentration
DOE	U.S. Department of Energy
DOE-HQ	DOE - Headquarters
DOE LAP	Department of Energy Laboratory Accredition Program
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
HPT	health physics technician
ICRP	International Commission on Radiological Protection
NCRP	National Council on Radiation Protection and Measurements
NRC	U.S. Nuclear Regulatory Commission
PAPR	powered air purifying respirator
R	roentgen
RWP	radiation work permit
SH&ES	safety, health, and environment support

Introduction

Policy

Battelle Columbus Laboratories Decommissioning Project (BCLDP) policy requires that staff members keep human exposure to ionizing radiation from both internal and external sources below the standards as defined in 5480.11 and as low as reasonably achievable (ALARA). This policy is achieved by using protective equipment, methods, and designs that are technically and economically effective. BCLDP's radiation protection program meets the high professional standards and remains responsive to applicable requirements of the U.S. Department of Energy (DOE), U.S. Nuclear Regulatory Commission (NRC), and other appropriate government regulatory agencies.

Organization and Responsibilities

The BCLDP Organizational Chart is depicted in Table 1.1. The chart shows the levels of management down to line management. The ultimate responsibility for implementation of the BCLDP Radiation Protection Program resides with the Decontamination Operations Manager. The Decontamination Operations Manager will ensure that the technical managers and building managers within the BCLDP provide the necessary support required for the successful implementation of the Radiation Protection Program.

Independent oversight of the Radiation Protection Program will be conducted by the Regulatory Compliance and SH&ES Oversight Department. This group will call upon the Radiation Safety Officer, the Radiation Safety Committee, and other professionals to conduct appraisals which are independent of the implementing body. RC and SH&ES oversight group will coordinate with QA as necessary to ensure an effective oversight program.

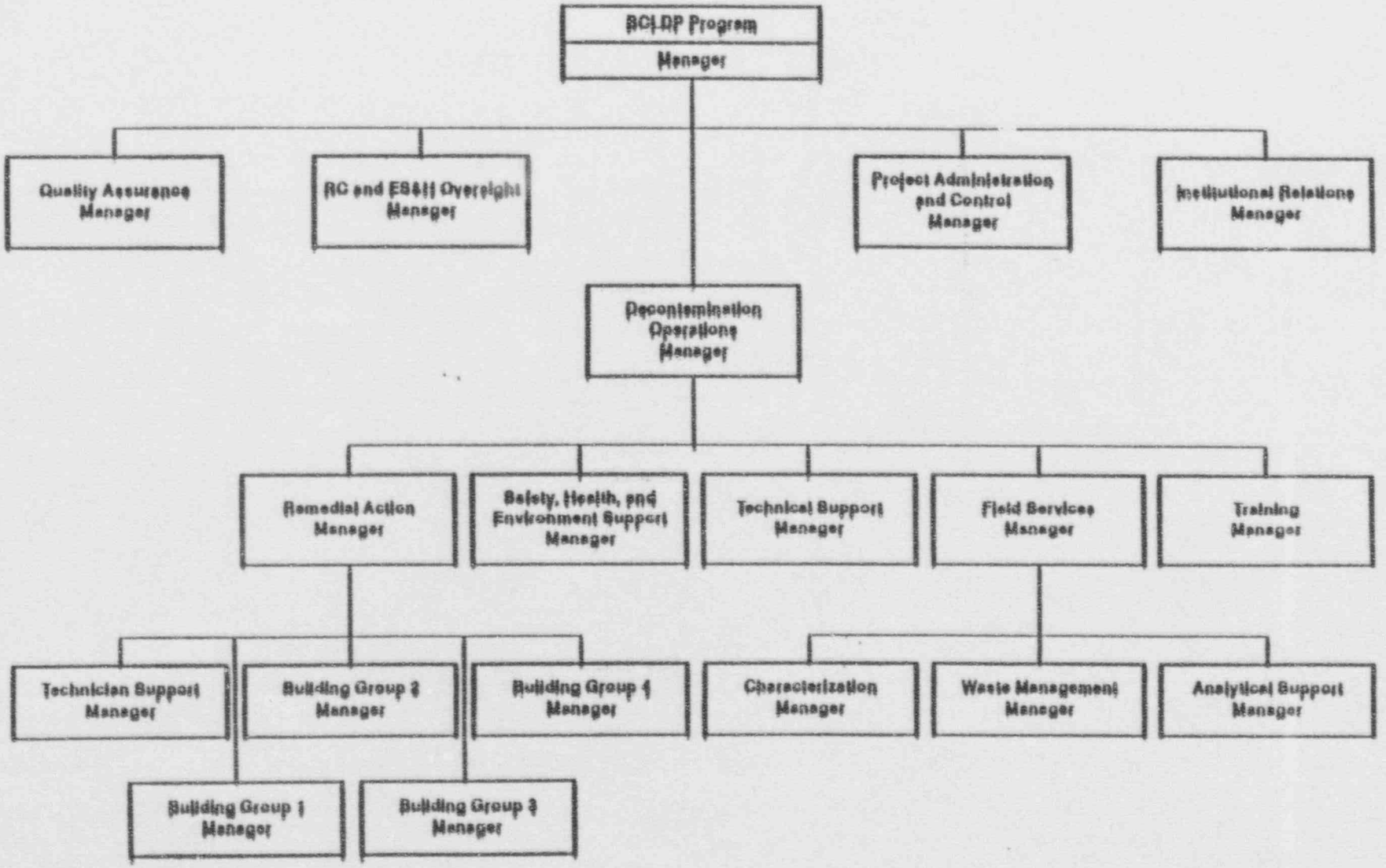
The daily implementation of the BCLDP Radiation Protection Program is charged to the Safety, Health, and Environmental Support Manager. This department provides health physics and radiation protection personnel for the activities associated with the radiation protection program. The responsibilities of this department include the following:

- appoint ALARA coordinator
- maintain BCLDP radiation survey data
- radiological posting of areas in accordance with applicable regulatory requirements
- implement and monitor the ALARA policy
- support radiation protection training
- develop BCLDP policies regarding radiation protection
- provide functions such as Radiation Protection Manager or equivalent for the BCLDP
- provide support services for health physics such as internal dose assessments, personnel exposure records review, and radiation shielding recommendations.

Line management (building managers) shall support the Safety, Health, and Environmental Support Department regarding the implementation of BCLDP Radiation Protection Program. Line managers will ensure consideration for aspects of radiation safety for daily activities such as general tasks, procedure writing, and employee training. Line management is charged with communicating openly with staff members regarding ALARA considerations, safety concerns, and waste management issues.

Staff members will implement fully the directives and policies as mandated in accordance with the BCLDP Radiation Protection Program. Each staff member is required to participate fully in radiation safety training exercises and to understand, to the best of their abilities, the BCLDP Radiation Protection Program. The final results

Table I-1. BCLDP Organizational Chart



of the BCLDP ALARA policy and Radiation Protection Program, impiemented by Management, will be measured by the staff member's exposure to ionizing radiation.

Stop Work Authority

Radiation protection personnel have the responsibility and authority to stop any work activity that poses an unreviewed radiological hazard or will violate the radiation protection measures required by BCLDP.

Program Content

This program presents the basic radiation protection standards for BCLDP staff members. The program requirements apply to all BCLDP operations at the West Jefferson and Battelle Columbus locations.

All individuals who work with radioactive materials shall be knowledgeable in the radiation protection requirements and shall adhere to the requirements stated in this program. Line management shall be familiar with the contents of this program and shall ensure that staff members have been provided with training in the radiation protection requirements that apply to the staff member's job assignments.

This program contains radiation protection practices that are based on requirements of various government organizations including DOE, NRC, the U.S. Environmental Protection Agency (EPA), and the State of Ohio, as well as recommendations of the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), and the American National Standards Institute (ANSI).

ALARA Philosophy

BCLDP radiation protection policy requires that occupational exposures of personnel and radioactive material releases to the environment be reduced to the lowest levels practical, commensurate with sound economics and good operating practices. BCLDP interprets the ALARA concept as reducing total personnel exposure to radiation. Implementation of the requirements presented in this manual should achieve this goal.

Environmental Monitoring

The impact of operations on the health and safety of the public is evaluated routinely by an environmental monitoring program. The basic objective of the environmental monitoring program is to evaluate the effectiveness of the BCLDP operations so that effluent levels are maintained as low as reasonably achievable and well within applicable standards.

Environmental monitoring under the BCLDP consists of routine monitoring of liquid and atmospheric media at the King Avenue and West Jefferson Nuclear Sciences Area. In addition, samples of various environmental constituents, including air, surface water, groundwater, grass, fish, food crop, sediment and soil are collected from the region surrounding the sites, and analyzed. The monitoring data is collected, reviewed, and reported to the public in an annual environmental report.

Variances

Any variance from the contents of this manual requires the approval of the manager of the Safety, Health and Environmental Support (SH&ES) Department.

Specific instructions for a variance can be found in BCLDP, *QA Manual Sections 15 and 16.*

Indication of Requirements

Throughout this manual, certain terms show the degree of rigor associated with specific criteria. *Shall*, *will*, and *must* are used to denote a requirement. *Should* and *would* are used to denote recommendations, and *may* is used to denote permission.

1.0 DOSE EQUIVALENT LIMITS, CONTROLS, POLICIES, AND RECORDS

1.0 Dose Equivalent Limits, Controls, Policies, and Records

1.1 Introduction

BCLDP bases its radiation protection policies on recommendations from ICRP, NCRP, DOE, and NRC. Occupational dose equivalent limits are maximum exposures. BCLDP has established administration limits below the limits specified in the DOE Orders and NRC regulations. Actual operations shall conform to ALARA practices.

1.2 Responsibilities

Safety, Health, and Environmental Support

Develop BCLDP's radiation protection policies and procedures. Ensure the policies and procedures comply with applicable DOE Orders, state and federal requirements, and intercontractor agreements.

Forward to Project Records within Regulatory Compliance and Environmental Safety and Health Oversight all manuals and other documented material that defines BCLDP policy and practices for radiation protection.

Develop operating controls to limit personnel exposures.

Aid in setting any restrictions on radiation exposure required for health purposes.

Promptly inform line management and staff of each staff member's routine exposure status.

Inform line management of the exposure status of any person involved in a radiation occurrence.

Record the results of all measurements that assess the radiological conditions in BCLDP facilities.

Evaluate the information needed for evaluation of internal or external exposure.

Provide pertinent radiation monitoring information needed for evaluation of internal or external exposure.

Provide data on exposures from offsite visits or employment.

Training

Training shall be provided per DOE Order 5480.11 and 10 CFR Part 20. Training records related to radiation protection shall be maintained in Project Records for inclusion in the individual's permanent records.

Line Management

Keep staff members informed of their exposure status.

Inform the SH&ES promptly of questions a staff member may have on radiation exposure status.

Inform female staff members of the radiation exposure limits for pregnant females.

Ensure that staff members' resultant exposure is commensurate with ALARA philosophy.

Staff Members

Provide documentation of prior radiation exposure history.

Forward reports of offsite radiation exposures to the SH&ES.

Inform the Dosimetry Section of any exposure of a personnel dosimeter from radiation therapy or diagnostic procedures.

Inform line management of any personal conditions that may affect the status of your exposure (including medical exposures and pregnancy).

1.3 Occupational Dose Equivalent Limits

The annual dose equivalent limits apply to persons 18 years of age and older who receive occupational exposure to ionizing radiation. See Exhibit 1.1 for those limits. The numerical values do not represent dose equivalents above which injury will occur. Rather, they represent a dose that should not result in any significant deleterious effect or an unacceptable risk of delayed effects. Maintaining exposure within the limits does *not* ensure that there is *no* risk to the individual. Therefore, management shall keep staff members' exposure to a practical minimum.

BCLDP maintains an occupational radiation exposure history file for all staff members. A staff member's radiation exposure history file shall include occupational exposure received at other nuclear installations. Both the calendar year and the life-time radiation dose equivalent totals shall include that exposure.

1.3.1 BCLDP Administrative Dose Equivalent Limits

BCLDP has established administrative limits for exposure of personnel to ionizing radiation to assist in the minimization of personnel exposure. (See Exhibit 1.2 for those limits.) Of particular importance are administrative whole body, skin of the whole body, extremity and other organ and tissue exposures, and hot particles. BCLDP has established, on a graded approach basis, administrative limits for these potential exposures to personnel. These limits assist in the administration of the ALARA program. BCLDP management uses administrative limits as a management tool. These administrative limits established by BCLDP management serve as another performance criteria to ensure that radiation exposure to personnel and the public is ALARA.

1.3.2 Planned Special Exposures

Any planned exposure that could result in an individual exceeding the limits in Exhibit 1.1 requires the approval of DOE. It also requires the express written authorization of the manager of SH&ES Department. Line management shall include a copy of this authorization in the individual's radiation exposure history file.

1.3.3 Unborn Child

The annual dose equivalent received by an unborn child as a result of occupational exposure of a female worker, who has notified line management in writing that she is pregnant, shall not exceed 0.5 rem (0.005 Sv). The exposure period shall be from conception to birth (the entire gestation period). Efforts should be made to avoid substantial variation above the uniform monthly exposure rate that would satisfy this limiting value. If the dose to the unborn child has already exceeded this limit by the time the worker notifies line management in writing, line management shall not assign the worker to tasks where additional occupational exposure is likely.

1.3.4 Member of the Public

The annual effective dose equivalent received by any member of the public at a BCLDP facility shall not exceed 0.1 rem (0.001 Sv). The dose equivalent to any tissue shall not exceed 5 rem (0.05 Sv) per year for any member of the public. This limit includes the skin and the lens of the eye.

1.4 Specific Requirements

This section describes the requirements BCLDP will use for determining individuals' dose equivalents.

1.4.1 Combining Internal and External Dose Equivalents

The effective dose equivalent includes the dose from external exposure to radiation and the dose from radionuclides deposited in the body. It does not include medical exposure, exposure to natural radiation background, or other exposure from sources unrelated to the individual's employment.

Intakes shall be assessed as long as *in vivo* or *in vitro* measurements confirm the retention of radionuclides in the body equivalent to 10% of the ALI. Exposures to the skin, extremities, and lens of the eye are not included in the determination of the annual effective dose equivalent.

1.4.2 Exposure Restrictions

Special approval is required for an occupational worker to enter a radiological area if the worker received an unplanned or accidental exposure above the limits in Exhibit 1.1. The approval shall be based on recommendations of appropriate health physics and medical personnel and have the concurrence of the worker. The BCLDP manager of Decontamination Operations must also approve the entry. Any dose received under the unplanned or accidental condition shall be included in the individual's exposure record.

If an exposure above the limits set in Exhibit 1.1 occurs, BCLDP shall not resume operations without the approval of the BCLDP manager. BCLDP must verify that the conditions that permitted the over-exposure have been eliminated. Investigating and reporting of the event shall be in accordance with BCLDP, *Off-Normal Event Reporting System and NRC Requirements*.

1.4.3 Air and Water Concentration Guides

Appendix A of 5480.11 contains derived air concentrations (DACs) for control of the work place. BCLDP shall *not* use the DAC or other air concentration values to calculate the internal dose equivalent received by a worker except when bioassay data are unavailable or inadequate.

1.4.4 Design and Control

Radiation exposure rates in controlled decontamination and decommissioning (D&D) workplace areas should be reduced to ALARA levels by proper facility design and control. The primary means of maintaining exposures ALARA are through physical controls, such as confinement, ventilation, remote handling, and shielding. Administrative controls and procedural requirements are to be considered supplemental means to achieve control.

During design of D&D operations, the following objectives shall be applied:

- Optimization principles, as discussed in ICRP Publication 37, shall be used for developing and justifying facility design modifications and physical controls.
- Personnel exposures from external sources in continuously occupied controlled areas shall be ALARA and shall not exceed 0.5 mrem/h (5 μSv/h) on average.
- Exposure of personnel to inhalation of airborne radioactive materials is to be avoided under normal operating conditions to the extent reasonably achievable. This shall be accomplished normally by confinement and ventilation.
- During D&D operations, the combination of design and control procedures in the work place shall ensure that the anticipated committed effective dose equivalent from intakes plus external sources will not exceed 5 rem (0.05 Sv) in a year. The anticipated committed dose equivalent to any organ or tissue from intakes plus external exposure shall not exceed 50 rem (0.5 Sv) in a year.

1.5 BCLDP Dose Equivalent Controls

The BCLDP controls contained in Exhibit 1.2 help ensure that personnel exposures are 1) necessary and adequately justified, and 2) maintained ALARA. The administrative controls are tiered; as a worker's cumulative dose increases, the level of administrative approval needed to authorize additional exposure increases. Prior to seeking the required approvals, the following conditions shall be met (see Exhibit 1.2):

- The staff member's radiation exposure status is known (his or her most recently worn dosimeter has been processed and a result obtained).

- There is a legitimate need for the staff member to exceed the administrative control. These needs include, but are not limited to the following examples: 1) the unique ability or experience of the individual will minimize the collective exposure, and 2) other qualified individuals with lower exposures are not available.

Authorization to exceed these administrative limits can be obtained by submitting a letter and requesting the exposure increase and obtaining the required approvals on the letter.

Normally within BCLDP, the effective dose equivalent to the whole body will be the limiting consideration. Active control of the effective dose equivalent to the whole body will, in most cases, adequately control skin and extremity doses.

1.5.1 Unborn Child

Line management shall advise female staff members of the requirements regarding potential radiation exposures to an embryo or fetus. The requirements include keeping exposure to the lowest practical level during the entire gestation period.

BCLDP management encourages any female staff member who enters radiological areas to inform line management (in writing) as soon as she suspects pregnancy. Line management will inform the staff member of the DOE limit for radiation exposure during pregnancy. That limit requires keeping the radiation dose to the embryo or fetus to the lowest practical level during the entire gestation period. The BCLDP control limit for this exposure is 0.5 rem (0.005 Sv) and shall not be exceeded for the entire gestation period.

SH&ES, line management, and the involved staff member shall, on an individual basis, determine methods for limiting exposure of pregnant females. Consideration shall be given to the difficulty in assessing the dose to the fetus from intakes of radionuclides by the mother. If the staff member's current assignment prevents achieving adequate control of potential exposure, line management shall provide a temporary reassignment.

1.5.2 Very High-Radiation Areas

Work in very high radiation areas, even for very short periods, requires the written approval of the manager of the SH&ES Department. The approval request must justify the >5 rem/h whole-body dose rate or >50 rem/h extremity dose rate.

1.6 Short-Term Controls

Line management shall prevent additional exposure if an individual's exposure status becomes uncertain or may have exceeded exposure controls. Line management shall promptly inform the SH&ES of the circumstances. The SH&ES, in cooperation with the Dosimetry Section, shall determine the staff member's exposure status. They shall recommend to line management any special exposure controls or restrictions. Line management shall implement these recommendations with the help of the SH&ES.

1.7 Occupational Exposure Policies

Adhering to the following exposure policies should prevent staff members from exceeding individual BCLDP exposure controls. The policies should prevent an

accidental exclusion of exposures that should be part of a staff member's exposure records.

1.7.1 Determination of Prior Dose

Before allowing any staff member entry into a radiation area, line management shall have an estimate of the individual's current annual exposure status. This includes the current annual dose resulting from internal or external exposure received during any previous employment. Based on that status, line management shall make sure the individual's exposure will not exceed dose equivalent controls as a result of work for BCLDP.

The new staff member shall provide BCLDP with a signed radiation exposure history form. The form either documents the staff member did not receive any current annual occupational radiation exposure, or it provides a listing where a current annual occupational exposure may have occurred.

If the individual documents a potential prior occupational exposure for the current calendar year, SH&ES may permit entry into radiological areas provided line management enforces the special controls placed on the staff member. SH&ES will require one of the following special controls:

- Until they determine the staff member's current annual exposure, the individual's dose must not exceed 50 mrem for the remainder of the year. Line management may request priority processing of the prior dose determination.
- If the SH&ES cannot get the staff member's prior dose, an estimate may be assigned.

A completed NRC-4 form or its equivalent (with the appropriate supporting documentation), signed by the staff member, is acceptable documentation of prior dose. The dose shown should be the record dose and not calculated or estimated.

The SH&ES will enter any exposure restriction into the individual's radiation exposure history file.

1.7.2 Dose Limitations

Special limitations on the occupational radiation exposure of an individual may be necessary. Limitations may be due to external exposure or exposure from internally deposited radionuclides. The SH&ES will provide restriction recommendations in writing to line management. Line management of the involved individual shall enforce those limitations.

The SH&ES shall provide in writing any occupational exposure limitations required for health reasons to line management. Line management of the individual involved shall enforce those limitations.

1.7.3 Offsite Occupational Exposure

Any staff member scheduling a business trip to an offsite location where there is a potential for radiation exposure must inform the SH&ES at least prior to the staff member's departure. Staff members shall provide the SH&ES with a signed exposure request form prior to leaving to perform work at or visit another nuclear installation. If the staff member's exposure is approaching quarterly or annual control limits, he or she may require special controls, which may include the use of supplemental devices identified by the SH&ES.

Staff members shall not use the normally assigned BCLDP personnel dosimeter while visiting or working at other nuclear installations. This requirement includes work in U.S. facilities as well as visits to nuclear facilities in other countries. Staff members may request a special dosimeter from the Dosimetry Section at least 1 week before the trip begins. Staff members may only use this special dosimeter for the offsite

assignment. They shall return the dosimeter to the Dosimetry Section upon return from the visit. The staff member shall continue to use his or her normally assigned dosimeter for any further onsite exposure measurements. Staff members who receive letters reporting any offsite exposure shall forward the letters to Dosimetry for inclusion in the individual's occupational exposure history file.

NOTE: Staff members who visit NRC-licensed or DOE-operated facilities do not need a special dosimeter before visiting the installation. The dosimetry assigned at the facility will provide the information needed for the individual's exposure record. The individual's BCLDP dosimeter must not be worn during the visit.

1.7.4 Medical Exposure

Any staff member who receives radiation exposure due to a medical exposure shall report the exposure to his or her management and Dosimetry. Medical exposures may include radiation therapy or administration of radioactive material under the control of a physician.

Staff members shall not wear assigned personnel dosimeters during medical (radiation therapy or diagnostic procedures) and dental radiation exposures. Staff members shall inform the Dosimetry Section if such exposure accidentally occurs.

1.7.5 Termination of Employment

Staff members who have received the appropriate termination forms shall have a final physical. The examination may be limited to an update of recent medical history if the last complete physical occurred within 6 months, no exposure to hazardous materials has occurred since then, and the employee has suffered no symptoms associated with exposure. Staff members who have been classified as Radiation workers shall receive appropriate bioassay measurements before completing the procedure.

1.8 Radiological Records

BCLDP maintains records containing radiological information that document staff members' routine activities and exposures throughout their BCLDP employment.

1.8.1 Record-Keeping

Radiological records shall

- show an individual's total accumulated radiation exposure
- describe any unusual exposures staff members received during their employment with BCLDP

Dosimetry shall maintain active personnel exposure and programmatic records and shall transfer inactive records to a records storage area.
The SH&ES shall collect records describing the radiological status of staff member's work environments and shall transfer those records annually to Project Records.

1.8.2 Individual Records

Dosimetry shall collect records of individual staff members. Staff members receiving records of exposure for offsite activities and from BCLDP contractors shall send them to Dosimetry for inclusion in the individual's radiation exposure history.

Examples of records for an individual's radiation exposure historical file include the following:

- annual effective dose equivalent received during the year from radioactive material deposited in the body
- annual dose equivalent to the organ or tissue of concern received during the year from radioactive material deposited in the body
- committed effective dose equivalent from intakes occurring during the year

- committed dose equivalent to the organ or tissue of concern from intakes occurring during the year
- annual effective dose equivalent from external sources of radiation received during the year
- annual dose equivalent to the lens of the eye
- annual dose equivalent to the skin
- annual dose equivalent to the extremity received during the year, including hands and forearm below the elbow and feet and legs below the knee
- other data having a bearing on the individual's exposure status, such as skin decontamination records
- summation of the annual effective dose equivalents received from external and internal sources during the year
- cumulative annual effective dose equivalent received from external and internal sources while employed at BCLDP since January 1, 1989
- data necessary to support or recalculate doses at a later date
- any respirator use restrictions
- previous employment exposure history
- special dose evaluations
- reports of unusual exposures or occurrences
- radiation work orientation and training
- respirator training and fitting
- work restrictions
- bioassay measurement results
- special instructions to females.

Personnel exposure records that identify an individual are strictly private information. Such records shall be available only to individuals needing them for the performance of their duties. The records shall be available to the individuals involved. The release of this information to uninvolved persons requires specific written approval of the individual or an authorized agent, unless required by law.

Each entry into the radiation exposure historical file shall include the measurement date and the identity of the individual to whom the data applies.

1.8.3 Reports to Staff Members

Exposure records are available to all staff members on an individual basis. Dosimetry provides exposure records to terminated employees as soon as the data are available but within 30 days of termination or request, whichever is longer.

Dosimetry provides each staff member with an annual statement showing a summary of their annual and cumulative effective dose equivalent. Dosimetry also provides a

staff member with a summary of their committed effective and annual effective dose equivalent from his or her involvement in an occurrence.

1.8.4 Records About the Radiation Protection Program

BCLDP maintains records that describe or support the scope, depth, and quality of the radiation protection program.

Records for the radiation protection program shall include:

- radiation protection policies and procedures
- procedures and methods for control and evaluation of individual exposure
- capabilities of dosimeters and instruments
- instrument calibration and maintenance procedures and schedules
- records of audit and performance tests showing the reliability of the measurement program.

EXHIBIT 1.1

Limiting Values for Assessed Dose from Exposure of Occupational Workers to Radiation

Type of Exposure	Annual Dose Equivalent Limit, rem (Sv)
Stochastic Effects	5.0 (0.05)
Nonstochastic Effects	
Lens of the eye	15.0 (0.15)
Extremity	50.0 (0.5)
Skin of the whole body	50.0 (0.5)
Organ or tissue	50.0 (0.5)
Unborn Child (entire gestation period)	0.5 (0.005)

ALARA EXPOSURE APPROVAL LIMITS

EXHIBIT 1.2

WHOLE BODY EXPOSURES	
$\leq$ 500 millirem per quarter	standard operating practice
$<$ 500 to $\leq$ 1000 millirem per quarter	requires review by and signature of SH&ES Manager
$>$ 1000 to $\leq$ 1250 millirem per quarter	requires reviews by and signatures of DOM and SH&ES Manager
$>$ 1250 to 1500 millirem per quarter	requires reviews by and signatures of DOM, and SH&ES Manager and Project Manager
EXPOSURES TO THE SKIN OF THE WHOLE BODY	
$\leq$ 1.5 rem per quarter	standard operating practice
$>$ 1.5 rem per quarter	requires review by and signature of the SH&ES Manager
One exception to this part:	see "hot particle exposures" below
EXTREMITY AND OTHER ORGAN AND TISSUE EXPOSURES	
$\leq$ 5 rem per quarter	standard operating practice
$>$ 5 to 7.5 rem per quarter	requires review by and signature of the SH&ES
One exception to this part:	see "hot particle exposures" below
HOT PARTICLE EXPOSURES	
75 microcurie-hours (μCi-hrs)	maximum allowable which will not result in acute deep ulceration of the skin Hot particles are discrete, highly radioactive, high dose rate objects ranging in size from microns to millimeters. Millicurie activity levels and dose rates in the hundreds of rad per hour are easily possible. Logically, these particles are the causes of over exposures in the industry and will have to be dealt with particularly when work is conducted in the hot cells. It is assumed that the particle in question is an irradiated fuel particle (any nuclide) of unknown size, but less than one millimeter in diameter and exhibits no self-absorption. The particle is assumed to be in direct contact with the skin and emit 10^{10} beta particles to an affected area of one square centimeter. Exceptions are granted to the requirements for exposures to the skin of the whole body and extremities. The reason for the exception is that hot particle exposures are, as yet, not well understood. Even when an estimate is not conservative, there is a good chance that exposure will exceed whole body (skin) or extremity dose limits regardless. Therefore, this is a special case. Hot particles shall be retained and logged; their compositions shall be determined and actual doses assessed using standards and equipment accepted by the industry. There is a definite possibility that multiple over exposures could occur without a definite plan which includes a hot particle survey procedure and increased personnel monitoring requirements.

EXHIBIT 1.3

Weighting Factors for Calculation of Effective Dose Equivalents

Organs or Tissues	Weighting Factor
Gonads	0.25
Breasts	0.15
Red Bone Marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder[a]	0.30

(a) "Remainder" means the five other organs or tissue with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, upper large intestine, or lower large intestine). The weighting factor for each remainder organ or tissue is 0.06. The extremities, skin, and lens of the eye are excluded from the "remainder" organs or tissue for assessment of effective dose equivalent.

2.0 CONTROL OF EXTERNAL EXPOSURE

2.0 Control of External Exposure

2.1 Introduction

The requirements in this section provide a basis for controlling personnel exposure. They will help reduce the chance of any person accidentally exceeding the dose equivalent limits. They will also help maintain personnel exposures ALARA. Also see Section 9.0, "ALARA".

2.2 Responsibilities

Safety, Health and Environmental Support

Maintain a knowledge of radioactive materials, equipment, and radiological conditions in BCLDP facilities that have a potential for personnel exposures.

Review radiological hazards involving radionuclides.

Advise management of methods that may reduce radiation exposures of personnel.

Prepare and supply radiation work permits (RWPs).

Aid in setting any restrictions on radiation exposure required for health purposes.

Line Management

Control activities of staff members so individual exposures do not exceed BCLDP controls. Ensure that staff members maintain their exposures ALARA.

Staff Members

Prepare work instructions for requesting new RWPs and provide to SH&ES.

Know the radiation levels in individual work areas. Conduct activities to maintain personal exposures ALARA.

Be aware of your exposure status to ensure it does not exceed BCLDP operating controls.

2.3 Control of External Exposure During a Job

Line management shall impose restrictions during individual job operations to help keep exposures within BCLDP's exposure limits. Line management shall control work time, as necessary, to ensure that exposures do not exceed the BCLDP controls in Section 1.0.

The RWP for a job shall specify the need for surveillance of exposure levels during work in the radiation area.

2.4 Control of Exposure Due to "Hot Particles"

Exposure to the skin from a "point" particle or a particle of unknown size but less than 1 cm in diameter must be limited to 10^{10} beta particles emitted from the radionuclides contained in the particle. For the case where 1 beta particle is emitted per disintegration, this limit may be expressed as 10 GBq s or 75 μCi h.

Potential "Hot Particle" areas will be identified and assessed. Appropriate control measures will be incorporated to minimize personnel exposures and support the ALARA program.

3.0 CONTROL OF INTERNAL EXPOSURE

3.0 Control of Internal Exposure

3.1 Introduction

BCLDP uses the following controls and procedures to reduce the chance of a personnel intake of radioactive material. In addition, BCLDP maintains sampling systems that alert staff members of potential internal intake of radioactive materials.

3.2 Responsibilities

Safety, Health and Environmental Support

Perform the necessary evaluation to determine the adequacy of the respiratory protection and air sampling programs.

Provide standards and technical information to maintain the adequacy of internal exposure controls.

Determine the airborne and surface contamination status of work locations throughout BCLDP facilities.

Define requirements for wearing protective clothing and respiratory protection equipment.

Line Management

Ensure staff members know and follow procedures set up to prevent internal exposures.

Staff Members

Know and follow procedures for preventing internal exposure, as described in this section and in the applicable RWPs.

Report any potential or actual exposures to line management and the SH&ES.

3.3 Protection Against Airborne Radioactivity

BCLDP shall prevent internal deposition of radionuclides as much as practical by using engineered controls (for example, confinement, ventilation). In addition, line management shall use administrative radiological controls to prevent airborne radioactivity and reduce surface contamination in work areas.

3.3.1 Respiratory Protection Equipment

This subsection contains requirements for use of respirators with radioactive materials. It also provides specific information pertinent to respirators commonly used for radiation protection purposes.

3.3.1.1 Respirator Protection Factors Respiratory protection factory shall be assigned as described in 10 CFR 20.

3.3.1.2 Use of Respiratory Protection Equipment

All respirator types, including PAPRs and supplied air, require a quantitative respirator facepiece fit.

Individuals shall *not* use half-mask type respirators for any work with radioactive materials that requires respiratory protection.

SH&FS shall specify requirements for using respiratory protection equipment before or during radiation work. Either potential or actual contamination may be the basis for the requirements.

The SH&ES shall determine the type of respiratory protection needed and assign them using an RWP.

Individuals may use only approved respirators. Individuals may not reuse respirators (i.e., one time use) until they have been cleaned, inspected, and reissued.

Workers should not wear respirators for more than 2 hours in one session or 6 hours in one day.

Individuals may not use filtered respirators for protection against radioactive materials in gaseous form. SH&ES may require supplied air hoods and plastic clothing to control personnel exposure to tritium and noble gases.

3.3.1.3 Respirator Use Responsibilities

Line management is responsible for ensuring their staff members are qualified to use respiratory protection equipment. Qualified staff shall have respirator fit, training, and medical clearance. Line management must be sure unqualified staff members do not enter areas that require respiratory protection.

Individual users shall perform a qualitative fit test of the respirator facepiece to ensure a proper seal prior to each use. They must perform this check before entering an area requiring the respirator. The individual shall not enter an area requiring respirators without a proper seal.

3.4 Workplace Air Sampling and Monitoring Program

The air sampling and monitoring program for the workplace should fulfill the following criteria.

- It should warn personnel of an accidental or unexpected release of radioactive material.
- It should provide data on the continued effectiveness or deterioration of containment mechanisms and procedures.
- It should provide an indication of the need for follow-up bioassay measurements.
- It should provide permanent data on the radiological conditions in the workplace.

SH&ES shall use data from air monitoring to assess the control of airborne radioactive material in the workplace. Personnel should not normally use the data to determine a dose equivalent to radiation workers.

All air filter media used to sample the work place (i.e., room samplers, grab samples) shall be analyzed and the data recorded for permanent record purposes.

3.4.1 Room Air Samplers

The room air samplers function as a measure of process control. They also provide a tool to check containment adequacy.

3.4.1.1 Locations for Room Air Samplers

As a general rule, room air sampler locations shall be located to maximize the chance of detection of airborne contamination. Room air samplers shall monitor each routinely occupied area where significant potential exists for radioactive releases into the workplace air.

The following shall be considered when determining the number of room air samplers required for each work area:

- the number of potential sources for a radionuclide release and the size of the potential source term
- the number of normally occupied work stations within the area
- the air flow patterns and potential for significant changes in normal air flow
- the chance of containment/confinement failure.

3.4.1.2 Criteria for Room Air Samplers

Each sampler shall have a stationary air flow rate measuring device, and the flow rate shall be verified at least once each 6 months using a calibrated flow rate measuring device.

3.5 Protection from Surface Contamination

Surface contamination must be controlled to reduce unnecessary external and internal exposure of staff members to radiation. The primary concern is to avoid internal exposure. Internal exposure can occur from the intake of radioactive material by inhalation, ingestion, or absorption through the skin. An additional concern is to prevent skin and clothing contamination. Personnel shall not smoke, (or use other tobacco products) eat, or drink, in contaminated or potentially contaminated radiological areas.

3.5.1 Protective Clothing Requirements

SH&ES shall prescribe the protective clothing for personnel entering locations with surface contamination areas. Individuals shall use the clothing prescribed in the RWP.

3.5.1.1 General Requirements

Staff members shall control protective clothing throughout its life as potentially contaminated equipment.

Personnel shall not wear protective clothing in uncontrolled areas without the approval of SH&ES supervision.

Each person entering a posted contaminated area shall wear the protective clothing specified in the RWP.

3.5.1.2 Radioactively Contaminated Laundry Requirements

Normally, individuals should use freshly laundered protective clothing. Individuals should inspect the clothing and segregate damaged items for repair or disposal. Contamination limits for nuclear laundry facility will be established in procedure.

Staff members shall segregate protective apparel as required by the laundry before returning for cleaning.

If protective apparel does not meet the laundry criteria, staff members shall dispose of the laundry as radioactively contaminated waste.

3.5.2 Skin Breaks

Personnel with skin breaks will not be allowed to work in contaminated areas unless they receive specific permission from SH&ES.

4.0 CONTROL OF VISITOR EXPOSURE

4.0 Control of Visitor Exposure

4.1 Introduction

A visitor is any personnel entering BCLDP hazardous materials facilities or areas who are not familiar with the potential hazards. BCLDP classifies visitors as either trained visitors, observers, or casual visitors. The classification depends on the nature of the visits and the potential exposure to ionizing radiation. This section describes the criteria BCLDP will follow in classifying and identifying visitors and applying the exposure limits. It also specifies radiation protection methods for visitors.

4.2 Responsibilities

Safety, Health and Environmental Support

Identify any special precautions and controls appropriate in the facility or area while visitors are present. Advise line management, or the escort appointed by line management, of the controls.

Dosimetry Section

Maintain records of the exposure received by each visitor.

Prepare reports of visitors' exposures during their visits.

Provide visitors with the dosimeters required for entry into BCLDP-controlled facilities or areas.

Line Management

Be aware of the presence of visitors in the facility or area.

Ensure that visitors wear the dosimeters that were issued to them.

Notify the SH&ES in advance of the time when the visitor must enter a controlled area.

Provide an escort for visitors (who is a radiation worker).

Limit the visitor's access or the work to ensure that the visitor's exposure does not exceed limits.

Staff Members

Report immediately to SH&ES any possible deviation from the established limits or possible contamination of the visitor.

Ensure that visitor compliance with the facility or area management and SH&ES instructions is maintained.

Collect visitors' BCLDP-issued dosimeters when visitors leave the BCLDP-controlled facilities or areas and return them to Dosimetry.

4.3 Trained Visitors

Trained visitors are business visitors with verified radiation safety training who are not employees of Battelle. These visitors may be allowed to enter a controlled area as nonescorted observers and are required to take the same training offered to occupational workers.

Dosimetry maintains exposure records for trained visitors. Line management shall limit the planned exposure of these visiting persons to

- effective dose equivalent--50 mrem/visit but not more than 100 mrem/yr

- dose equivalent to any tissue (including the skin and lens of the eye)—400 mrem/visit but not more than 4 rem/yr.

Planned exposure above these limits requires approval from the visitor's employer. If a trained visitor's employer specifies in writing controls more restrictive than the above, SH&ES shall apply the more restrictive controls.

BCLDP requires each trained visitor to have the proper dosimeter before entering a BCLDP-controlled facility or area.

Line management shall provide Dosimetry and SH&ES with the following information for each trained visitor:

- visitor's name (first name, middle initial, last name)
- visitor's social security number (or birthdate if social security number is not available)
- name and address of employer
- beginning and ending date of visit
- name of person visited (or escort).

4.4 Casual Visitors

Casual visitors are those persons who visit BCLDP-controlled facilities or areas escorted or as part of a tour. They will be escorted by a radiation worker the entire time they are in a controlled area. The escort shall be familiar with the radiation protection requirements for that radiation area. This staff member shall ensure that the visitors meet all protection requirements applicable to that radiation area.

Line management shall ensure that a casual visitor's exposure during a tour of BCLDP-controlled facilities or areas does not exceed 10 mrem/day.

BCLDP line management shall notify, in writing, SH&ES and Dosimetry about a tour or visit. Line management shall supply the following information:

- date, time, and duration of the planned visit
- the purpose of the visit and the identification and address of the visiting group
- name and social security number (or birthdate if social security number is not available) of each visitor
- route of the visit, including building numbers
- name and payroll number of escort.

Dosimetry will assign personnel dosimeters to cover about 10% of the casual visitors in a group. A minimum of two visitors in each group shall have a dosimeter. If a visitor will not remain in the assigned group, Dosimetry will assign a dosimeter to all individuals. The Dosimetry Section will apply any positive dosimeter results to each group member not assigned a dosimeter.

Line management shall provide the SH&ES and Dosimetry with a tour record. The record shall contain a listing of the participants and the dose received by the wearer of the dosimeter.

Line management shall not permit tour groups to enter radiological areas without the specific, written, prior approval of the Manager of SH&ES. Line management shall provide a copy of this approval to SH&ES and Dosimetry for inclusion in the records of the tour group.

On leaving a radiological or controlled area, a health physics technician shall survey each visitor. If the health physics technician detects contamination, he or she shall contact SH&ES supervision and line management immediately.

If there is evidence of surface contamination, airborne activity, or abnormal external exposure before, during, or after the visit, line management shall contact SH&ES immediately.

4.5 Report of Radiation Exposures to Visitors

BCLDP shall maintain a record of the exposure received during each visit by a trained or casual visitor. Dosimetry shall report all exposures >50 mrem to the visitors or their employer within 30 days of the determination of the exposure.

BCLDP shall report any exposure above the limits listed in this section to the visitor and his or her employer within 24 h of the determination of the exposure. BCLDP may need to make other notifications, depending on the exposure. See BCLDP procedure, QA-AP-16.2, *Reporting, Investigation, and Corrective Action for Occurrences Under DOE Contract W-7405-ENG-92*, for additional information.

5.0 OCCUPATIONAL DOSE MEASUREMENT AND EVALUATION

5.0 Occupational Dose Measurement and Evaluation

5.1 Introduction

BCLDP maintains external and internal dosimetry programs to ensure an accurate evaluation of radiation doses. These programs provide quantitative and timely dose information and demonstrate compliance with DOE limits. This section describes the basic methods and requirements for detecting and measuring the external and internal doses of BCLDP staff members.

5.2 Responsibilities

Safety, Health, and Environmental Support

Provides radiation measurement information that will permit evaluation of doses that personnel dosimeters cannot measure.

Provide the technical evaluation and guidance to limit the staff member's work as a result of internal deposition of radionuclides.

Provide dose measurement information for short-term control of personnel external dose.

Provide monitoring data on radiation occurrences and routine work environments to aid in the evaluation of internal and external dose.

Dosimetry Section

Record the occupational dose of staff members.

Set up the minimum external and internal dosimetry requirements for staff members and visitors.

Perform the necessary evaluations to determine the adequacy of the external and internal dosimetry programs.

Approve secondary dosimeter methodology and measurements used to supplement individually assigned dosimeters.

Periodically review records to ensure proper assignments of personnel dosimeters, dosimeter holders, and bioassay measurements.

Inform line management of appropriate bioassay measurements for staff members who are terminating.

Schedule staff who require bioassay measurements.

Determine occupational radiation dose equivalent received and issue reports to the SH&ES.

Set up calibration and dosimetry methods by which BCLDP will measure the occupational radiation dose of staff members.

Provide guidance on bioassay measurements and frequency.

Medical Department

Collect dosimetry and bioassay data from Dosimetry and store in the Occupational Medicine Database.

Share data in the Occupational Medicine Database with Health Physics and Medical Services as required.

Line Management

Identify staff members who require bioassay measurements.

Ensure appropriate bioassay measurements are completed before assigning staff members to work with radioactive materials. Ensure staff members also receive appropriate measurements if internal exposure conditions (for example, radionuclide type or form) change.

Ensure that staff members are available for bioassay measurements, and submit samples as required.

Implement special exposure controls for those staff members whose dose is approaching quarterly or annual controls. This includes those who will be performing radiation area work at offsite facilities.

Ensure that staff members receive and wear current dosimeters and appropriate holders.

Ensure that staff members exchange personnel dosimeters on the dates scheduled by the Dosimetry Section.

Restrict staff members from working in radiological areas if they are not in compliance with exposure monitoring requirements (bioassay, dosimeter assignment).

Contact SH&ES when a staff member receives diagnostic or therapeutic radioactive materials.

Staff Members

Always wear the assigned personnel dosimeter during working hours, whether working in assigned BCLDP facilities or entering other Battelle facilities.

Participate in scheduled bioassay measurements.

Contact line management if physician dispenses diagnostic or therapeutic radioactive materials. Provide SH&ES with a note from the physician stating the type and quantity of material dispensed.

5.3 Measurements of External Dose

Dosimetry

The Dosimetry Section uses the individually assigned dosimeters as the primary technique to determine the dose from external sources. Dosimeter types include multi-purpose, beta/photon, basic, and finger ring.

The dosimetry provided shall be DOELAP approved. Individual dosimetry records will be reviewed by the dosimetry group and SH&ES to ensure that exposures appear to be reasonable.

5.3.1 Assignment of Personnel Dosimeters

The following requirements apply to the assignment of personnel dosimeters.

1. The Dosimetry Section will make personnel dosimeter assignments based on the potential of an individual receiving a dose during entry into radiation areas.

   Each year, Dosimetry and SH&ES shall review dose records and current work assignments. Based on that review, they shall determine if individuals have the proper dosimeter assigned.

2. Dosimetry may change a staff member's dosimeter assignment during the year. SH&ES and line management must review and approve the assignment change. Dosimetry may change the assignment of a multipurpose for a basic dosimeter at the end of any quarter.

3. Dosimetry shall assign an extremity (ring) dosimeter to a staff member if any of the following conditions are expected to occur:

   - in the judgment of the Dosimetry Section, the average ratio of the extremity to whole-body dose rate exceeds 10 to 1

   - the individual's extremity dose is highly variable during the work.

5.3.2 Requirements for Wearing Dosimeters

Staff members shall wear assigned dosimeters according to the following requirements:

1. The dosimeter shall be at or above the waist and at the front of the body. The face of the badge shall be away from the body.

2. Individuals shall orient ring dosimeters on the hand to increase the response of the dosimeter to the radiation source.

3. Individuals shall inform line management immediately of dosimeter problems. Examples of problems include suspected or known mistreatment, contamination, loss, or damage.

4. Staff members shall promptly inform health physics of any instance where individuals perform radiation work without the dosimeters required by the RWP.

5. Basic, beta/photon, multipurpose, and ring dosimeters are reliable when given reasonable care. However, the results may be erroneous if the thermo-luminescent material is exposed to excessive light or heat. Similarly, a pencil dosimeter may lose its charge if opened, severely jarred, or immersed in liquids. Individuals must take care to avoid subjecting dosimeters to such abuse.

6. Staff members shall not allow dosimeters to receive radiation exposure as a result of medical or dental procedures or any other nonoccupational exposure.

7. Individuals should take every reasonable effort to prevent contamination of dosimeters. In areas requiring two layers of protective clothing, individuals should wear the dosimeter on the inner layer. If the dosimeter is worn on the outer layer, individuals should enclose it in a plastic bag.

8. Staff members should not take assigned dosimeters home. Staff members shall not place dosimeters near sources of radiation or in locations with unusually high temperatures ($>140°F$).

9. Normally, staff members shall not use assigned dosimeters offsite. See Section 1.0 for use of dosimeters specifically assigned for offsite use.

10. Where required, staff members shall wear pencil dosimeters on the front of the body at or above the waist. The dosimeter shall be read by the staff member

before entering and after exiting their work area at a minimum and more frequently if the dose levels require it. Dosimetry shall be notified immediately if a dosimeter is dropped or otherwise severely jarred.

5.3.3 Estimation of Dose Equivalent If BCLDP must provide an estimate of an individual dose equivalent instead of an actual dosimeter measurement, the following applies:

1. BCLDP will get a result for each dosimeter. BCLDP will assume the individual received any dose measured by an assigned dosimeter unless an evaluation shows the result is invalid.

2. If an assigned dosimeter result is lost, Dosimetry shall determine the probable dose received during the period in question. Dosimetry shall process form DDO-043, "Staff Member Personnel Exposure Questionnaire for Lost/ Damaged Personnel Dosimeters", to document the dose.

3. If SH&ES determines an assigned dosimeter result is invalid, Dosimetry shall establish the individual's dose. Dosimetry shall also provide a dose estimate in writing to the SH&ES.

4. Line management shall ensure that the involved staff member is told of all changes to reported doses. The staff member should acknowledge the change by signature. BCLDP will make the change regardless of whether the staff member signs, and note the lack of acknowledgement on the change document.

5. SH&ES shall use approved methods to estimate the dose to the skin and shall provide a written estimate of the skin dose received to the SH&ES.

6. The SH&ES shall approve estimates or measurements determined by any method other than measurement by individually assigned dosimeters.

5.4 Measurement of Internal Dose

BCLDP uses field measurement to detect any potential for worker exposure to radioactivity. Examples of these field measurements include workplace air sampling, nasal smears, and contamination surveys.

BCLDP uses bioassay measurements, including *in vivo* measurements, urinalysis, and fecal analyses for radionuclides to confirm and assess internal exposures.

Staff members shall receive (and provide samples for) their bioassay measurements within 1 month of the originally scheduled date. Line management shall restrict staff members with overdue bioassay measurements from entering radiation areas until they receive the required measurements.

5.4.1 Initial Bioassay Line management shall ensure that staff members receive a initial bioassay measurement, as specified by Dosimetry, *before* qualifying them as radiation workers. Individuals must also receive a bioassay measurement before line management may allow them to work with unsealed radioactive materials.

5.4.2 Routine Evaluation Line management shall ensure that staff members who work with unsealed radioactive material receive a periodic bioassay.

Staff members who work with combinations of materials shall receive a periodic bioassay. SH&ES and the Manager of SH&ES shall review and approve the bioassay program chosen for BCLDP staff members.

5.4.3 Special Bioassay

BCLDP may schedule staff members for a special bioassay measurement whenever there is evidence of a possible intake. The SH&ES will recommend if staff members involved in an off-normal event require special bioassay measurements.

Special bioassay measurements performed at the request of a staff member require the concurrence of the line manager.

5.4.4 Final Bioassay

BCLDP shall schedule staff members for a final bioassay measurement based on the following:

- Staff members who are reassigned so they do not work with radioactive materials shall receive a final bioassay measurement at the time of transfer.
- All terminating staff members who are radiation workers shall receive a bioassay measurement within 1 week of termination.

6.0 CONTROL OF PERSONNEL ACCESS TO SOURCES OF RADIATION EXPOSURE

6.0 Control of Personnel Access to Sources of Radiation Exposure

6.1 Introduction

This section describes the methods used 1) to identify those areas where radiation protection controls are required and 2) to ensure that radiation protection controls are communicated to staff members.

6.2 Responsibilities

Safety, Health, and Environmental Support

Monitor personnel exposure conditions, including radiation exposure rates and surface contamination and airborne radioactivity levels.

Establish radiologically controlled areas.

Assist line management in minimizing the levels of radiation and contamination exposure to personnel.

Specify the radiation protection requirements or restrictions for keeping personnel exposures at or below operational controls and ALARA.

Prepare RWPs.

Establish procedures to control radiation work in and personnel access to radiological areas.

Require that current RWPs and operating procedures are available, posted, and followed.

Provide and maintain supplies of required radiological protective equipment.

Require that staff members entering a radiological area be aware of the significance of the area. Ensure staff members know they are responsible for following the requirements of the applicable RWP.

Maintain personnel exposures at or below operational controls and ALARA.

Staff Members

Attend radiation worker training as required for entry into radiological areas.

Follow the requirements of the applicable RWP.

Exercise reasonable care in the performance of work.

Inform management and SH&ES of any failure of control procedures or protective equipment.

Maintain personal exposure at or below occupational controls and ALARA.

6.3 Area Designations

The potential for both external and internal exposures is the basis for radiological area designations. If the area only has an external exposure potential, the personnel exposure potential is the designation standard. These designations include radiation area, high-radiation area, or very high-radiation area. If an area also contains radioactive material or has an internal exposure potential, the posting of the area will identify the exposure source. Those identifiers include radioactive material, airborne radioactive material, and surface contamination.

6.3.1 Uncontrolled Area

An uncontrolled area is any area not within a radiologically controlled area.

The dose equivalent rates in uncontrolled areas shall be less than 0.2 mrem/h.

Radioactive materials are not permitted in uncontrolled areas unless packaged according to the requirements of *49 CFR100-177.*

6.3.2 Controlled Areas

A controlled area designation is used to protect individuals by controlling exposure to radiation and access to radioactive materials.

The SH&ES shall establish a controlled area when any of the following conditions exist:

- It is adjacent to a radiological area and could become contaminated by accidental spreads or releases from the radiological area.
- It may occasionally contain radioactive material due to the transportation of radionuclides between radiological areas.
- The anticipated whole-body dose equivalent rate exceeds 0.2 mrem/h.

6.3.3 Radiological Areas

A radiological area is any area within a controlled area where any of the following conditions exist:

- An individual can receive a dose equivalent greater than 2 mrem in 1 h at 30 cm from the radiation source or any surface through which the radiation penetrates.
- Airborne radioactive concentrations greater than 1/10 of the DACs (see Appendix A) are present.
- Loose surface contamination levels are greater than those specified in HP-OP-012, *Posting and Access Controls.*
- An individual could receive a dose equivalent exceeding 80 mrem in 1 year during normal occupancy.

The SH&ES uses the following external exposure potential criteria to classify radiological areas within a controlled area. In addition to the radiological area designation, the source of the radiation (radioactive material, surface contamination, or airborne radioactivity) is included in the posting of an area.

Radiation area—any location where an individual can receive a dose equivalent greater than 5 mrem but less than 100 mrem in 1 h at 30 cm from the radiation source or from any surface through which the radiation penetrates.

High-radiation area—any location where an individual can receive a dose equivalent of 100 mrem or greater but less than 5 rem in 1 h at 30 cm from the radiation source or from any surface through which the radiation penetrates.

Very high-radiation area—any location where an individual can receive a dose equivalent of 5 rem or greater in 1 h at 30 cm from the radiation source or from any surface through which the radiation penetrates.

6.4 Access to Radiological Areas

All radiological areas shall have access control consistent with the degree of hazard.

6.4.1 General Access Requirements

Permanent radiological areas require walls, fences, or some other means to prevent access to prohibit entry other than through the normal entrances.

Contaminated areas where a high potential for spread of contamination exists require a step-off pad at the entrance. The posted RWP instructs staff members as to the type of protective clothing required. The instructions on the step-off pad shall inform staff members how to exit the radiological area.

6.4.2 Access Requirements for High- and Very High-Radiation Areas

High- and very high-radiation areas require at least one of the following:

- entrance or access point with a control device that 1) functions automatically to prevent entry when a high- or very high-radiation area exists, 2) permits entry only after the radiation level is reduced below 0.1 rem/h, and 3) prevents use or operation of the radiation source, thereby preventing the existence of a high- or very high-radiation area while an individual is in the area

- a control device that energizes a conspicuous visible alarm signal so that the individual entering the area is aware of the radiation level and SH&ES staff members are aware of the entry (administrative procedures shall define the required actions of personnel to activated alarms)

- locked entry ways, except during periods when access to the area is required, with positive control over and radiation surveys made for the initial entry and periodically as necessary

- control devices that will automatically generate audible and visible alarm signals to alert staff members in the area before use or operation of the radiation source and in enough time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

Transient conditions within a radiation area resulting in exposure rates greater than 100 mrem/h at 30 cm from the radiation source shall require placing a suitable barrier around the area and posting the area as high- or very high-radiation area, as appropriate. The area shall not be left unattended unless the access door(s) are locked and posted as restricted access. If access cannot be locked, line management responsible for the area shall provide continuous surveillance to prevent unauthorized entry to the area. Transient conditions shall not exceed an 8-hour time period.

6.5 Posting and Labeling

The signs described in this section meet radiological posting requirements. Other signs used for special applications require the approval of the SH&ES.

Posting for Airborne Radioactive Material

Access to any area where airborne radioactive material concentrations greater than 1/10 of the DACs (DOE Order 5480.11, Table 1) are present shall be clearly and conspicuously posted with a sign that identifies the radiological conditions that exist (e.g., "Airborne Radioactivity").

Posting for Surface Contamination

Access to any area where surface contamination levels specified in HP-OP-012 are present shall be clearly and conspicuously posted with a sign that identifies the radiological conditions that exist (e.g., "Surface Contamination").

6.5.1 General Posting and Labeling Requirements

The purpose of radiological posting and labeling is to identify the actual or potential presence of radiation or radioactivity. Uncontrolled areas are not posted. Any radiological signs or tags not included in this manual shall be approved by the SH&ES.

The SH&ES shall direct all radiological posting. Posted signs shall be clearly visible to personnel entering a radiological area.

Movement or removal of posted radiological signs by personnel other than SH&ES staff members is not permitted. Staff members may remove tags from empty uncontaminated containers. (If the container is removed from a radiological area, a health physics technician shall release the container.)

Posting of areas defined by a chain or radiation rope shall be visible from any reasonable avenue of approach. Signs shall be no farther than 30 m apart.

Radiological postings including labeling of fissionable material requires the use of a radiation symbol (trefoil) that conforms with ANSI standard N2.1-1969. The background color for radiological signs shall be yellow, the symbol color shall be magenta, and lettering shall be black.

6.6 Radiation Work Permit

This subsection provides requirements for RWPs and describes how staff members can obtain an RWP.

6.6.1 General RWP Requirements

Staff members shall not enter a radiological area unless a current RWP is available and entry is allowed. In case of accident or emergency conditions, emergency procedures control personnel access to sources of radiation. Visitors shall enter a radiological area only under the conditions described in Section 4.0.

All work in a radiological area shall be performed under the provisions of the RWP.

The SH&ES forwards the original of all RWPs to Project Records for enclosure in the historical file.

Line management shall post all current RWPs at the work site. The posting location shall be such that staff members are not required to enter the radiological area to determine the requirements of the RWP.

6.6.2 Obtaining an RWP

Line management is responsible for obtaining RWPs and initiating the request for an RWP.

6.6.3 RWP Content

The RWP shall contain the following information:

- RWP number
- the time period covered by the RWP (the SH&ES will automatically void the RWP on the date shown unless line management requests an extension)
- specific work location(s)

- description of the nature and extent of the work authorized
- description of the radionuclides, including maximum quantities allowed
- known or estimated dose rates, protective equipment requirements, and any special instructions
- additional ALARA requirements
- the signatures of the SH&ES supervisor and the building manager.

6.6.4 RWP Review Requirements

The SH&ES supervisor and line management shall review each RWP before its void date and shall revise, void, or extend it.

The immediate supervisor of the staff member performing the work shall also review the requirements and limitations of the RWP.

6.7 Radiation Protection Coverage

Line management requires a second person present during any work that presents a significant hazard potential to a worker. That second staff member shall stay close to the work area to help the worker if he/she needs emergency assistance. This requirement is even more important during off-shift hours when the normal building occupants are not present.

If the hazardous work is with radioactive material, SH&ES policy requires radiation monitoring coverage by a health physics technician; i.e., a health physics technician is available near or at the work area to provide any needed radiation monitoring. Line management shall request this monitoring for work during both regular and off-shift hours.

The health physics technician can provide the second-person coverage for other potential emergency assistance besides radiation monitoring. Both the health physics technician and the worker shall agree that the health physics technician will perform both functions before starting the work.

If a significant personnel hazard does not exist, the work may not require either radiation monitoring or second-person coverage; however, both line management and the SH&ES supervisor shall agree in advance that the work does not need radiation monitoring.

7.0 CONTROL OF RADIOACTIVE MATERIAL

7.0 Control of Radioactive Material

7.1 Introduction

Staff members may use or store radioactive material only in radiological areas. The radioactive material may leave these areas only under specific procedures that provide for safety and accountability.

7.2 Responsibilities

Line Management

Know the types and quantities of radioactive or contaminated material and equipment present within the facility.

Limit the inventory of radioactive material in facilities to ensure quantities do not exceed limits. The general safety assessment document or safety analysis reports contain those limits.

Safety, Health, and Environmental Support

Ensure custodians maintain accurate inventories of accountable nuclear materials as specified in instructions from the Safeguards Section.

Ensure that a health physics technician surveys and releases all items leaving BCLDP control.

Maintain a surveillance program that shows the radiological status of materials, equipment, and facilities.

Advise operating management of the controls appropriate for radioactive or contaminated items.

Provide radiation release surveys.

Include additions and disposals of sources in the inventory records.

Arrange for leak testing of sealed sources within the required time frame.

Notify line management of any missing source.

Staff Members

Know and follow procedures for maintaining contamination control and maintaining radiation exposures ALARA.

Follow the provisions of applicable RWPs.

Inform management of deficiencies in or violations of control procedures.

Contact the SH&ES promptly upon receipt of radioactive material.

7.3 Definitions

Radioactive material is any material or combination of materials that spontaneously emit ionizing radiation.

NOTE: Certain commercially available chemicals or similar items contain radionuclides in amounts that would make them radioactive. If the items are not used in, or were never brought into, a radiological area, SH&ES may consider them to be nonradioactive. If the items are ever used in a radiological area, SH&ES will consider them to be radioactive. The reason for this requirement is the difficulty in ensuring that no new or additional radionuclide has been introduced.

Detectable contamination is a level of contamination that can be measured using approved methods and portable instruments representing the current technology.

Nondetectable contamination is a level of contamination that cannot be measured using approved methods and portable instruments representing the current technology.

Until released by an evaluator, SH&ES considers items or material in a radiation area potentially contaminated. The applicable RWP shall specify any exceptions.

7.4 Control of Radioactive Contamination

Staff members must control radioactive or contaminated items to prevent an accidental spread of radioactive material.

CAUTION: **Before starting any decommissioning work or disposing of equipment and facilities, special nuclear material (SNM) custodian shall assess the potential release of fissionable material.**

7.4.1 General Criteria

Staff members should limit the materials taken into radiological areas to those amounts necessary to accomplish the work assigned. They should adequately shield waste or other radioactive material stored in radiation areas normally occupied by personnel.

RWPs shall normally specify controls on the quantities of radioactive material allowed in the radiation areas. If the material is fissionable and requires criticality controls, the RWP may not specify quantities.

7.4.2 Ventilation Systems

Intake ventilation systems shall be provided with either HEPA filtration or fail-safe backflow prevention to minimize the chance of release of particulate through the inlet path.

All exhaust ventilation HEPA filters required for preventing environmental releases or releases to occupied areas require testing. Personnel shall perform the test immediately after placement, and at least annually, using a cold aerosol testing procedure. Each HEPA filter or filter bank shall be at least 99.95% efficient. The test shall include pressure drop measurements across each filter bank. The testing personnel shall replace a filter when the pressure drop exceeds the manufacturer's recommendations or when the filtering efficiency is below 99.95%. HEPA filters used to reduce duct contamination or extend the life of primary filters are exempt from testing. Examples of exempt filters are those located directly within shielded hot cells, hoods, or gloveboxes.

7.4.3 Vacuum Cleaners

Unless approved by Health Physics supervision, Vacuum cleaners used in radiological areas shall have a HEPA-filtered exhaust. Vacuum cleaner shall be labeled radioactive materials and be used only for radioactive constituents. The HEPA filter shall be aerosol-tested in place and be at least 99.95% efficient before placing the vacuum cleaner in service. The equipment custodian shall have the filter retested annually. Any seal disturbance also requires retesting.

7.4.4 Radioactive Sources

The requirements of this section apply to all radioactive material that meets the definition of a source, except as noted below.

NOTE: Sources contained in items generally available to the public are exempt from these inventory and reporting requirements. Sources in smoke detectors and self-luminous products are examples of exempt sources. Contact SH&ES to determine if other sources are exempt.

For this program, the following definitions will apply:

- *Radioactive source* - any item containing radioactive material used exclusively for its emitted radiation and which retains its physical form and configuration during use.

- *Sealed source* - a radioactive source sealed in a capsule or having a bonded cover; the capsule or cover being strong enough to prevent contact with or dispersion of the radioactive material under normal conditions of use.

- *Unsealed source* - a radioactive source containing radioactive material attached to a surface or embedded in a matrix of nonradioactive material (any source not fully meeting the definition of a sealed source). SH&ES must permanently mark all sources or source holders to permit individual source identification. Source identification shall consist of:

- unique source identification number

- material type (radionuclide, material form)

- activity and date of assay.

All new sealed sources must meet the performance requirements as specified in ANSI standard N542. The SH&ES manager or a delegate must approve in writing any deviation from this requirement.

7.4.4.1 Leak Test Requirements

Qualifying sealed sources must be leak tested before placing them in service. ANSI N542 states the quantities required for leak testing. SH&ES will review sealed sources made with those radionuclides on an individual basis for leak test requirements. The source custodian shall tell SH&ES if he or she has a qualifying sealed source containing any of those radionuclides. Sealed sources containing radionuclides in gaseous form are exempt from leak testing (except tritium).

All qualifying sealed sources shall also be leak tested at intervals not exceeding 6 months. SH&ES shall document the survey results of the leak test. Any leak test that reveals the presence of ≥ 0.005 μCi of radioactive material provides evidence that the source is leaking.

SH&ES shall immediately withdraw from service any leaking source and repair or properly discard the source.

SH&ES shall immediately remove from service any source not leak tested in the last 6 months and place the source in appropriate storage until a health physics technician performs a leak test. If a source cannot be located when testing is due, a report must be sent immediately to line management. BCLDP will report the source to the appropriate regulatory agency as "missing" radioactive material if it cannot be found.

7.4.5 Controlled Equipment

Certain regulated items may contain contamination on normally inaccessible surfaces. That contamination requires radiological control for inspection or servicing activities. In some cases, SH&ES may exempt the item from storage and use within a radiation area. The following criteria apply to controlled items.

- The item shall be free of smearable contamination on accessible surfaces.

- The dose rate at any accessible surface shall not exceed 1 mrad/h beta-gamma.

- Radionuclides classified as highly radiotoxic shall not be present.

- Staff members shall identify controlled items using a firmly attached tag or label. The identification shall include the radiation survey results. The labeling shall also include instructions to prevent removal of the items without the prior approval of SH&ES. The tag or label shall remain on the items until a health physics technician releases it.

7.5 Covering Over Radioactive Contamination

This section provides requirements and guidelines for covering radioactive contamination.

7.5.1 Painting Over Contamination

The following general criteria apply to all painting over of radioactive contamination.

- Line management may not substitute painting of surface contamination in lieu of cost-effective decontamination efforts.

- A health physics technician must survey all potentially contaminated surfaces before painting. The health physics technician shall survey normally accessible surfaces for both smearable and fixed alpha and beta-gamma contamination.

7.5.2 Contamination and Approval Levels

Staff members must get the prior written approval of SH&ES.

7.5.3 Documentation

Line management must document any painting over of known or suspected contamination. The documentation shall

- have a number assigned by the SH&ES

- include justification for fixing contamination in place rather than removal

- include control of the area

- include an evaluation of the assumed risk in painting rather than complete decontamination.

7.6 Radiation Release Surveys

This section provides requirements for the two types of radiation release surveys.

7.6.1 Release Survey Exemptions

Release surveys are not required for people leaving BCLDP-controlled areas. The surveys required in Section 7.8 provide acceptable controls. Other specific instances and conditions where the policy does not normally apply include the following:

- removal of items routinely carried between work and home from a radiologically controlled area (for example, security badges, books, papers, lab notebooks, pens and pencils, hand-held calculators, personal items)

CAUTION: **Staff members shall not bring certain personal effects into a radiological area if they will be working with radioactive material.**

NOTE: If an individual detects any radioactive contamination on clothing or skin, a health physics technician must perform a survey of personnel and appropriate items. Contact SH&ES supervision for additional i information about survey requirements.

7.6.2 General Release Survey Requirements

A health physics technician shall survey any item or material being removed from an area where contact with radioactive materials may have occurred. Staff members shall request this survey before they remove items from BCLDP facilities or from SH&ES controls.

When performing a radiation release survey, a health physics technician must include all accessible surfaces. Detecting radioactive contamination on items being removed from radiological areas is a principal concern; however, BCLDP must also consider that other items could have unknowingly become contaminated. Also, labels identifying contamination may become covered or detached from the item.

7.6.3 Unconditional Release

An unconditional release means a health physics technician has surveyed all accessible surfaces of the item with appropriate portable instruments and found residual contamination less than the criteria stated in Table 7.1. The criteria in Table 7.1 represent the upper bound for contamination limits. Materials released for unrestricted use per the release criteria will be considered for further decontamination in accordance with ALARA. (See Section 7.3 for the definitions of detectable and nondetectable contamination.) If the item has inaccessible surfaces, an authorized staff member must also provide an evaluation that shows the item could not be internally contaminated. There are no restrictions placed on the use of unconditionally released items.

It is BCLDP policy that all items leaving BCLDP radiological areas will receive an unconditional release survey, except as described in Section 7.6.1. SH&ES maintains a routine survey program for all areas under BCLDP control; however, this program in itself cannot provide enough assurance to prevent transfer of contamination to the public. Therefore, this policy applies regardless of the item's current location. Specific examples of when staff members must request an unconditional release include returning items to a vendor and excessing equipment or furniture.

Inaccessible surfaces of equipment may become contaminated even when accessible surfaces are free of contamination. An evaluator may unconditionally release the item only when the design or usage of the equipment removes any chance of interior contamination and all accessible surfaces have been surveyed and found to be free of detectable radioactive contamination. If practical, staff members should dismantle the equipment so a health physics technician can completely survey interior surfaces. Before evaluating an item to be free of contamination, the SH&ES representative should be sure of the following:

- The design of the equipment prevented contamination of the inaccessible surfaces during use.
- If decontaminated in the past, those efforts did not introduce contamination to inaccessible surfaces.

NOTE: SH&ES supervision may waive the requirement for evaluation for some items being unconditionally released from controlled or uncontrolled areas. This requirement shall only be waived if SH&ES supervision determines it is unlikely that the item could be internally contaminated. The waiver shall be in writing. The health physics technician shall attach this waiver to the release survey report instead of the evaluation form. A waiver shall not be used when material historical certification is possible or for items released from radiation areas.

TABLE 7.1

ACCEPTABLE SURFACE CONTAMINATION LEVELS
FOR UNCONTROLLED RELEASE OF EQUIPMENT

Nuclide[a]	Average[b,d]	Maximum[b,c,e]	Removable[b,c,e]
U-nat. U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2	[illegible] cm^2
Transuranics. Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	[illegible]
Th-nat. Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Adapted from Regulatory Guide 1.86 (Ref. 30).

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting reactides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emissions by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contamination should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionately and the entire surface should be wiped

NOTE:
The SH&ES group shall designate those individuals who may serve as evaluators.

7.7 Personal Effects

7.7.1 Personal Effects in Radiation Areas

The following requirements apply to personal effects taken into radiological areas.

SH&ES shall prescribe protective clothing to prevent the contamination of personnel and their effects under normal conditions. The staff member shall make every effort to prevent contamination of personal effects. Staff members shall restrict personal effects to those required in the normal course of work in the radiation area. Examples of required personal effects are underclothing, shoes, socks, prosthetic appliances, and eyeglasses.

SH&ES may approve wearing personal clothing for cold temperature protection when performing work in radiation areas. Individuals should wear this clothing *under* the required protective clothing.

7.7.2 Contamination Surveys

Periodic contamination surveys are necessary to prevent the spread of radioactive contamination. The following requirements apply to any work with radioactive material.

7.7.2.1 Personnel Surveys

A personnel survey is a comprehensive check of an individual's potentially exposed clothing, personal effects, and body for radioactive contamination. Any individual who works with radioactively contaminated items shall have a personnel survey on completion of the work. The RWP shall specify if any additional surveys are necessary. Qualified radiation workers may perform self-surveys; a health physics technician shall survey all others. Individuals shall perform self-surveys for contamination with the appropriate alpha and beta-gamma detection instruments.

7.7.2.2 Instrumentation Detection Equipment

Individuals shall use detection equipment appropriate for the type of contamination involved for personnel contamination surveys. SH&ES will recommend the instrumentation needed.

7.7.2.3 Personnel Contaminations

A health physics technician shall perform the exit surveys if an off-normal event occurs that may have resulted in personnel contamination. The health physics technician shall also perform the exit surveys if the RWP so specifies.

7.7.3 Personnel Contamination Release Criteria

Line management shall normally not allow personnel with detectable contamination to eat or go home. Line management must get the prior approval of the SH&ES manager before permitting either action.

SH&ES shall direct all skin decontamination of personnel. The decontamination techniques shall be procedures approved for personnel decontamination.

7.8 Receipt of Radioactive Material

Staff members shall contact SH&ES upon receipt of radioactive materials before further handling. A health physics technician shall perform a survey of the external surfaces of each package.

Individuals shall open all packages in a radiological area having appropriate contamination controls. When possible, the unpackager shall open small packages in a fume hood. When the shipper provides unpackaging instructions with the shipment, the unpackager shall follow the instructions. The unpackager shall have continuous health physics technician coverage during the unpackaging operation. The health physics technician shall survey each containment layer for radiation, contamination, or damage as the unpackager exposes them. The unpackager shall inform the SH&ES's hazardous material transportation officer (HMTO) of any deficiency. Deficiencies include contamination, leakage, or otherwise not following shipping regulations.

The unpackager shall remove or destroy all U.S. Department of Transportation (DOT) shipping labels upon emptying the package. He or she shall dispose of or salvage packaging materials and reusable containers according to standard waste disposal procedures. The health physics technician shall survey reusable shipping containers both internally and externally. If the health physics technician finds contamination, the container shall be either decontaminated or appropriately sealed and labeled. If decontamination of inner surfaces is not practical, the unpackager shall be sure external surfaces are free of smearable contamination. After the unpackager securely closes the container, the health physics technician shall appropriately label it to show its contamination status.

7.9 Radioactive Material Storage

This section applies to radioactive and contaminated materials removed from service and stored for possible reuse. It does not cover materials used in performance of day-to-day tasks and materials in transit.

7.9.1 General Storage Requirements

The following general criteria apply to the storage of all radioactive material:

- Line management shall keep stored quantities of radioactive or contaminated materials to a minimum. Line management and SH&ES shall periodically review storage locations. Line management shall dispose of those items that are no longer needed.
- RWPs governing the storage area(s) shall specify the maximum dose rates at the surface of stored items.
- Line management having ownership is responsible for radioactive material until it is disposed of or transferred to another owner. The responsible line manager shall provide all necessary manpower, materials, and funding to accomplish any work required for proper storage.
- Staff members should store and process natural, depleted, or enriched uranium and natural thorium away from highly toxic alpha emitters.
- Storage containers shall provide at least one containment barrier.

7.9.2 Outside Storage

Radioactively contaminated material may not be stored outside without prior written approval of the Decontamination Operations Manager. SH&ES staff shall get documented approval of the appropriate level of management before storing any radioactive material outside.

Outside storage of radioactively contaminated material must also follow these requirements.

- The storage must have a current RWP.
- The radioactive material package must withstand the natural elements such as wind, rain, and snow. Packaging shall provide a minimum of two containment barriers unless waived by SH&ES supervision.
- SH&ES must post the storage area as a radioactive materials area and other postings as appropriate.
- The SH&ES shall place the area on a routine surveillance program.
- SH&ES shall review the outside storage and justify outside storage rather than disposal or relocation to indoor storage.

8.0 RADIATION SAFETY TRAINING

8.0 Radiation Safety Training

8.1 Introduction

BCLDP's radiation safety training program provides staff members with the knowledge and skill to perform their radiation work safely. This section identifies radiation protection training requirements for all staff members whose work involves potential radiation exposures.

8.2 Responsibilities

Line Management

Identify and document radiation safety training required for each staff position.

Ensure that all new staff members receive radiation protection orientation.

Ensure that staff members who need unescorted access to radiation areas receive radiation worker training before conducting such work and annual retraining thereafter.

Provide and document appropriate job-specific training and annual retraining for radiation workers.

Ensure that radiation workers receive respiratory protection training at least annually.

Safety, Health and Environmental Support

Provide technical content for new staff member's radiation protection training.

Conduct, test, and document training and retraining for radiation workers as requested by line management.

Conduct, test, and document qualification and requalification for health physics technicians.

Audit all radiation protection training and retraining.

Training

Maintain radiation protection training documentation.

Maintain auditable records of each staff member's job-specific radiation protection training and retraining.

8.3 Requirements

The following subsections contain the minimum requirements for BCLDP radiation safety training.

Occupational Workers

Line management shall ensure that all occupational workers who may enter a controlled area receive training in radiation protection within 1 month of his or her initial assignment to and prior to potential exposure to radiation at that facility. Line management shall not allow any unescorted person to enter a controlled area until he or she receives the training. Line management shall ensure that occupational workers receive retraining whenever there are significant changes to radiation protection policies. Occupational workers who enter controlled areas should receive refresher training annually.

The level of training is to be commensurate with the staff member's job assignment. The initial training shall include the following, as a minimum:

- the risk of low-level occupational radiation exposure, including cancer and genetic effects

- the risk of prenatal exposure
- basic radiation protection concepts
- DOE and BCLDP radiation protection policies and procedures
- staff and management responsibilities for radiation safety
- emergency procedures.

Line management may waive generic training (not specific to a facility) provided the following items apply:

- The staff member received the training at another DOE facility.
- Line management has documentation of the training that contains the individual's name, date of training, and specific items covered.
- An appropriate official has certified the training of the individual.

6.3.1 Radiation Workers

Line management shall ensure that radiation workers receive training and retraining to familiarize them with the basics of radiation protection and the ALARA process. Training should include both classroom and applied training and should emphasize procedures specific to the individual's job assignment. The level of training in the following topics is to be commensurate with each worker's assignment. The training shall include the following, as a minimum:

- radioactivity and radioactive decay
- characteristics of ionizing radiation
- man-made radiation sources
- acute effects of exposure to radiation
- risks associated with occupational radiation exposure
- special considerations in the exposure of women of reproductive age
- dose equivalent limits
- mode of exposure--internal and external
- dose equivalent determinations
- basic protective measures--time, distance, shielding
- specific BCLDP procedures for maintaining exposures ALARA
- radiation survey instrumentation--calibration and limitations
- use of portable radiation detection instruments for personal surveys
- radiation monitoring programs and procedures

- contamination control, including protective clothing and equipment and workplace design
- personnel decontamination
- emergency procedures
- warning signs and alarms
- responsibilities of employees and management
- interaction with SH&ES staff
- procedures associated with specific job assignments (for example, gloveboxes). See Section 8.3.4 on job-specific training and retraining.

BCLDP considers that a staff member who has received the above documented training is a qualified radiation worker. Radiation workers may enter BCLDP radiation areas unescorted. The refresher training shall be conducted annually. A radiation worker requires retraining to maintain qualification as a radiation worker.

Line management may waive generic radiation oritectuib training (not specific to a facility) provided the following items apply:

- The staff member received the training at another DOE facility.
- Line management has documentation of the training that contains the individual's name, date of training, and specific items covered.
- An appropriate official has certified the training of the individual.

Line management shall have certification of a radiation worker's knowledge of radiation protection basics. The certification should be determined by examination.

8.3.2 Safety, Health, and Environment Technicians

SH&ES management shall ensure that there is a health physics technician training and retraining program that meets the requirements of DOE 5480.11. The training shall familiarize the health physics technicians with the concepts of radiation protection and proper procedures for maintaining exposures ALARA and shall include both classroom and applied training.

The training shall precede or be concurrent with assignment as a health physics technician while under the supervision of a trained individual. SH&ES management shall have assurance (by examination) that the health physics technician has the knowledge and is qualified in the radiation protection basics.

The training shall include topics listed in DOE 5480.11 and should also include procedures specific to the facility(s) where the health physics technician will work. The level of training in each topic is to be commensurate with the health physics technician's assignment.

Health physics technicians must complete a retraining cycle every 2 years to maintain their qualification status.

8.4 Documentation

Line management shall document training in enough detail to determine the adequacy of the training. This documentation should include the following:

- a description of the material presented
- the attendees' printed names and social security number
- attendees' signatures and date
- payroll numbers
- section cost code
- location of training/retraining
- evaluation of the effectiveness of the training (written examination, oral examination, or observation of performance)
- trainer's signature and date

Personnel providing the training or retraining shall send *original* documentation to the Training Coordinator and a *copy* to the staff member's manager, if requested.

8.5 Visitors

Visitors are persons who are not staff members of Battelle and are unfamiliar with the hazards of the BCLDP sites (refer to Section 4.0). A qualified radiation worker shall normally escort and supervise all visitors entering BCLDP radiation areas. Visitors may not require general radiation worker training unless their work requires unescorted access to BCLDP radiation areas. Visitors shall be subject to briefing on escorting requirements and certain radiation protection requirements.

9.0 ALARA

9.0 ALARA

9.1 Introduction

This section defines the requirements of the BCLDP program to maintain radiation exposures as low as reasonably achievable (ALARA). The BCLDP radiological ALARA program consists of the following program elements: ALARA goals, prejob planning, ALARA reviews, and ALARA audits.

9.2 Responsibilities

Manager, SH&ES Department

Appoint the BCLDP radiological ALARA coordinator.

Line Management

Review work environments, procedures, and equipment to maintain staff exposure ALARA.

Actively promote the ALARA philosophy.

Attend ALARA prejob planning meetings, as required.

Be aware of the effective dose equivalent status of staff members reporting to you and provide timely effective dose equivalent status reports to staff members.

Assist in the development of ALARA goals.

Staff Members

Maintain your exposure and your coworkers' exposures to radiation ALARA.

Make suggestions to line management about ways to reduce your exposure.

Attend and participate in required prejob planning meetings.

BCLDP Radiological ALARA Coordinator

Provide guidance to BCLDP staff and line management on maintaining staff exposure to ionizing radiation ALARA.

Develop ALARA goals.

Provide monthly and quarterly reports on the status of the BCLDP ALARA program to line management.

Provide annual reports on the BCLDP ALARA program to the Manager of SH&ES and line management.

Conduct and document ALARA audits.

Conduct and document ALARA design reviews.

Conduct an active program to maintain staff awareness of the BCLDP ALARA program.

Review and approve exposure evaluations for staff members whose effective dose equivalent may exceed the BCLDP administrative dose equivalent limits described in Section 1.3.1.

Document the measures that are taken to control radiation exposures.

Review applicable RWPs.

Review individual and collective effective dose equivalent and advise workers and line management of their current effective dose equivalent status.

Attend ALARA prejob planning meetings.

9.3 Organization

Line management is responsible for conducting operations in such a manner that exposure to radiation is ALARA and supports the BCLDP ALARA policy.

The BCLDP radiological ALARA coordinator administers the BCLDP radiological ALARA program. The manager of the SH&ES Department appoints the BCLDP radiological ALARA coordinator and ensures the BCLDP ALARA policy.

9.4 Establishing ALARA Goals

ALARA goals are the primary performance indicators for the BCLDP ALARA program. ALARA goals may be either facility-related or organization-related.

9.4.1 Requirements

ALARA goals shall be developed and submitted in writing to BCLDP Management by the BCLDP ALARA coordinator no later than December 1 for the upcoming calendar year.

9.4.2 Guidance on Development of ALARA Goals

ALARA goals should be specific, measurable, and have one or more clearly defined end points.

Goals related to reduction of personnel exposure may address one or more of the following measures:

- average dose equivalent for a group, job classification, task, or location
- maximum individual dose equivalent for a group, job classification, task, or location
- collective dose equivalent for a group, job classification, task, or location.

ALARA goals related to reduction of personnel exposure may also address identification and elimination of nonproductive radiation exposure.

ALARA goals may address other dose-related measures not listed here.

ALARA goals not related to the reduction of personnel radiation exposure may address one or more of the following measures:

- total square footage classified as radiological areas
- total square footage classified as radiological controlled areas
- number of individual radiological or radiological controlled areas
- square footage of contaminated areas

- number of person-hours spent in respirators.

ALARA goals may address other non-dose-related measures not listed here.

9.4.3 Format for ALARA Goal Submittals

ALARA goal submittals shall include the following:

- responsible line manager's signature
- site or facility
- statement of the goal
- performance indicators, including dates for completion
- the name and telephone number of the cognizant staff member (this staff member should be able to respond to an ALARA audit of the goal).

9.4.4 Revisions to ALARA Goals

With the approval of the BCLDP radiological ALARA coordinator, line management may revise ALARA goals at any time during the calendar year. Line management should resubmit revised goals as described in Section 9.4.3.

9.5 ALARA Audits

The BCLDP radiological ALARA coordinator shall audit ALARA goals at least annually.

Audits of ALARA activities shall include a review of prejob planning meeting records and radiation dose tracking records.

9.6 ALARA Reports

Periodic ALARA reports provide line management with the information necessary to assess the effective dose equivalent status of their organizations.

9.6.1 Monthly Radiation Dose Status Report

The monthly effective dose equivalent status report provides effective dose equivalents received by staff as of the most current dosimeter processing. The report includes whole-body, skin, extremity, and neutron doses. The status report gives the effective dose equivalent for the current processing, calendar year-to-date, and are extrapolated to year end. The report also includes a summary of BCLDP and DOE radiation dose limits. This report is strictly private.

9.6.2 Semi-Annual ALARA Progress Report

The semi-annual ALARA progress report summarizes BCLDP's radiation effective dose equivalent and skin contamination statistics for the calendar year-to-date. It also presents the status of ALARA goals. This report identifies those groups that are required to take specific actions to meet BCLDP ALARA program requirements.

9.6.3 Annual ALARA Report

The annual ALARA report provides documentation of the activities related to the BCLDP ALARA program. It also summarizes radiation effective dose equivalent statistics for tracking purposes, and meets the requirement of DOE 5480.11 to provide an annual analysis of performance and lessons learned.

9.7 Radiation Dose Tracking

The purpose of tracking radiation effective dose equivalent is to provide line management with the information necessary to ensure that doses are in fact ALARA.

9.7.1 Individual Doses

The Dosimetry Section provides individual radiation effective dose equivalents (for those staff members on a monthly dosimeter exchange frequency) to line management through the monthly effective dose equivalent status report. Record effective dose equivalents are normally available within about 1 month of the dosimeter exchange.

Line management must control the dose equivalent received between dosimeter exchanges. Line management may accomplish this by estimating whole-body doses using self-reading pocket (pencil) dosimeters or electronic dosimeters.

The BCLDP Radiological ALARA coordinator should maintain a log of estimated dose equivalents from the most recent record dose through the current date: 1) use the most recent record effective dose equivalent as the starting point for the log; 2) add dose equivalents that were estimated by pencil or electronic dosimeters to the most recent record effective dose equivalent to get a running total; 3) update the log upon receipt of the next record effective dose equivalent.

The BCLDP Radiological ALARA coordinator shall keep each staff member advised of his/her record and estimated effective dose equivalent. In addition, the ALARA coordinator shall keep line management informed of the current effective dose equivalent status of each staff member.

9.7.2 Extrapolated Doses

Line management shall prepare quarterly evaluations of radiation exposure for any staff member whose effective dose equivalent may exceed 2,000 mrem at year end.

The monthly radiation effective dose equivalent status report and the monthly review of high exposures and skin contaminations both include extrapolated doses.

9.7.3 Collective Dose

Collective effective dose equivalent (person-rem) is an important indicator of the effectiveness of dose equivalent control measures.

The monthly radiation effective dose equivalent status report includes collective effective dose equivalent by section. The operations ALARA coordinator should maintain a log of collective effective dose equivalent for the group.

Line management shall provide a projected collective effective dose equivalent for the upcoming calendar year whenever the collective annual effective dose equivalent for a section for the previous year exceeds 1 person-rem.

9.8 Prejob Planning

Line management shall ensure that staff conduct prejob planning for any job expected to result in a collective dose equivalent rate of 100 person-mrem/day or greater.

Prejob planning will normally take the form of a personnel briefing held immediately before performing a job. The purpose of these briefings is to ensure that staff involved in the job understand where and how it is to be done, the radiation protection requirements, and what measures should be taken to control radiation doses and radioactive contamination.

9.9 ALARA Debriefings

The operations ALARA coordinator should conduct a debriefing meeting upon completion of jobs involving collective dose equivalent of greater than 100 person-mrem. Debriefings should include the following:

- identification of problems encountered
- techniques for improving the future performance of similar tasks, including techniques for further reducing exposures
- comparison of actual dose equivalent for the job to the estimated dose equivalent
- lessons learned and recommendations for future jobs.

9.10 ALARA Reviews

This section describes the ALARA reviews required for certain radiological work. ALARA reviews are also required for changes to existing facilities and for new facility design.

9.10.1 ALARA Job Reviews

Radiological work, including new experiments, shall receive ALARA review. SH&ES shall review all work instructions. Exhibit 9.1 provides guidelines for ALARA job reviews. Where applicable, ALARA job reviews shall include consideration of the optimization principle.

9.10.2 ALARA Design Reviews

The primary means for maintaining exposures ALARA are through physical controls, such as confinement, ventilation, remote handling, and shielding.

All changes to existing facilities shall receive an ALARA review by the SH&ES as part of the modification permit review process.

Design of new facilities, as well as changes to existing facilities, shall include the use of optimization principles for developing and justifying facility designs and physical controls. ICRP Publication 37 provides guidance on the application of the concept of optimization.

9.11 ALARA Training

General radiation worker training shall include a discussion of the ALARA principle and BCLDP's ALARA policy. This training shall also include specific procedures for maintaining exposures ALARA (including the use of time, distance, shielding, and any other factors).

Line management shall provide additional, job-specific ALARA training as appropriate.

EXHIBIT 9.1

ALARA Job Review Considerations

- ALARA
  - Shielding
    - For workers
    - For assistants
    - For RPTs
    - In low-dose waiting areas
    - Types
      - Blankets
      - Bricks
      - Water
      - Matting
      - Sheet lead
      - Lead glass
      - Lead gloves
      - Lead aprons
  - Remote Handling
    - Manipulators
    - Tongs
    - Tweezers
    - Special tools
    - Cranes
    - Robotics
  - Temporary Confinement
    - Greenhouses
    - Tents
    - Plastic on floor
    - Glovebag
    - Airlocks
    - Filtration
    - Ventilation (air balance)
  - Decontamination
    - Drain/flush systems
    - High pressure wash
    - Vacuum
  - Remove Sources
    - Shielded position or area
    - Lock and tag
  - Worker Comfort
    - Ice vests
    - Time in Mask
    - Air supply
  - Communications
    - Radios
    - Hand signals
- RWP Requirements
  - R PT coverage
  - Protective Clothing
  - Respiratory protection
  - Dosimetry
  - RAMs
  - CAMs
  - Air monitoring
  - Posting
  - Temporary radiation areas
  - Radiological hold points
- SOPs
- Variances
- Notifications
  - Other operations groups
  - Building manager
- Required Equipment
  - Tools
  - Bags
  - Protective clothing
- Job Assignments
  - Number of personnel required
  - Briefing
- Qualifications
  - Radiation worker training current
  - Job-specific training
  - Mask fit
  - Whole body count
- Training
  - Dry runs
  - Mock-ups
- Contingency Plan
- Radiological Conditions
  - Maximum whole body dose rate
  - Maximum extremity dose rate
  - Contamination levels
  - Airborne contamination
- Current Exposure Status of Personnel
- Cleanup
  - Status of work area on completion of job
  - Decontamination
- Job Completion
  - Debrief workers
  - Lessons learned

APPENDIX E

BCLDP DECOMMISSIONING PLAN

DD-93-19
Revision 0

DECOMMISSIONING PLAN FOR THE BATTELLE MEMORIAL INSTITUTE COLUMBUS OPERATIONS

to

U.S. NUCLEAR REGULATORY COMMISSION

MAY 1993

Prepared by

BATTELLE
505 King Avneue
Columbus, Ohio 43201

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Attachment 3. Current Index for BCLDP Procedures and Plans
Attachment 4. Biographical Information
Attachment 5. Facility Post-Decontamination Final Status Survey

1. General Information

Licensee Name:	Battelle Memorial Institute
License Address:	505 King Avenue, Columbus, OH 43201-2693
License Number:	SNM-7

1.1 Introduction

On April 16, 1943, Battelle Memorial Institute (BMI), acting through what is now its Columbus Operations (BCO), entered into Contract No. W-7405-ENG-92 with the Manhattan Engineer District to perform atomic energy research and development (R&D) activities. From that time until 1988, BCO performed nuclear materials research and development work at these privately-owned facilities for the Manhattan Engineer District and its successor agencies — AEC, ERDA, and DOE. BCO also performed commercial nuclear operations, and work for other Federal agencies such as the Department of Defense (U.S. Air Force, U.S. Army, U.S. Navy), and NASA.

The BCO facilities, comprising 15 buildings and associated grounds located at BCO's King Avenue Site, Columbus, Ohio, and West Jefferson North and South Sites, West Jefferson, Ohio, became partially radiologically contaminated as a result of the performance of such work. These facilities now require decontamination to original status (i.e., unrestricted use).

It has been determined that DOE, as the successor to the AEC and the Government's earlier work, has predominant liability and responsibility for decontamination and decommissioning (D&D) of the BCO facilities. At the direction of the Assistant Secretary for Nuclear Energy (ASNE) (May 29, 1986 memorandum, Voight to Vaughan, approved by Vaughan, June 10, 1986), D&D of the BCO facilities described herein was accepted into DOE's Surplus Facilities Management Program as a Major Project, entitled Battelle Columbus Laboratories Decommissioning Project (BCLDP).

Battelle also holds U.S. Nuclear Regulatory Commission (NRC) license number SNM-7. Battelle has continually operated in full compliance with this NRC license and plans to perform this decommissioning in compliance with NRC regulations. Accordingly, this decommissioning plan is being submitted to the NRC for review and approval. It does not constitute a declaration to terminate license number SNM-7. Battelle plans to continue to operate under the license conditions and to request renewal at the appropriate time.

2. Description of Planned Decommissioning Activities

2.1 Decommissioning Objective, Activities, Tasks, and Schedules

2.1.1 Need for Action

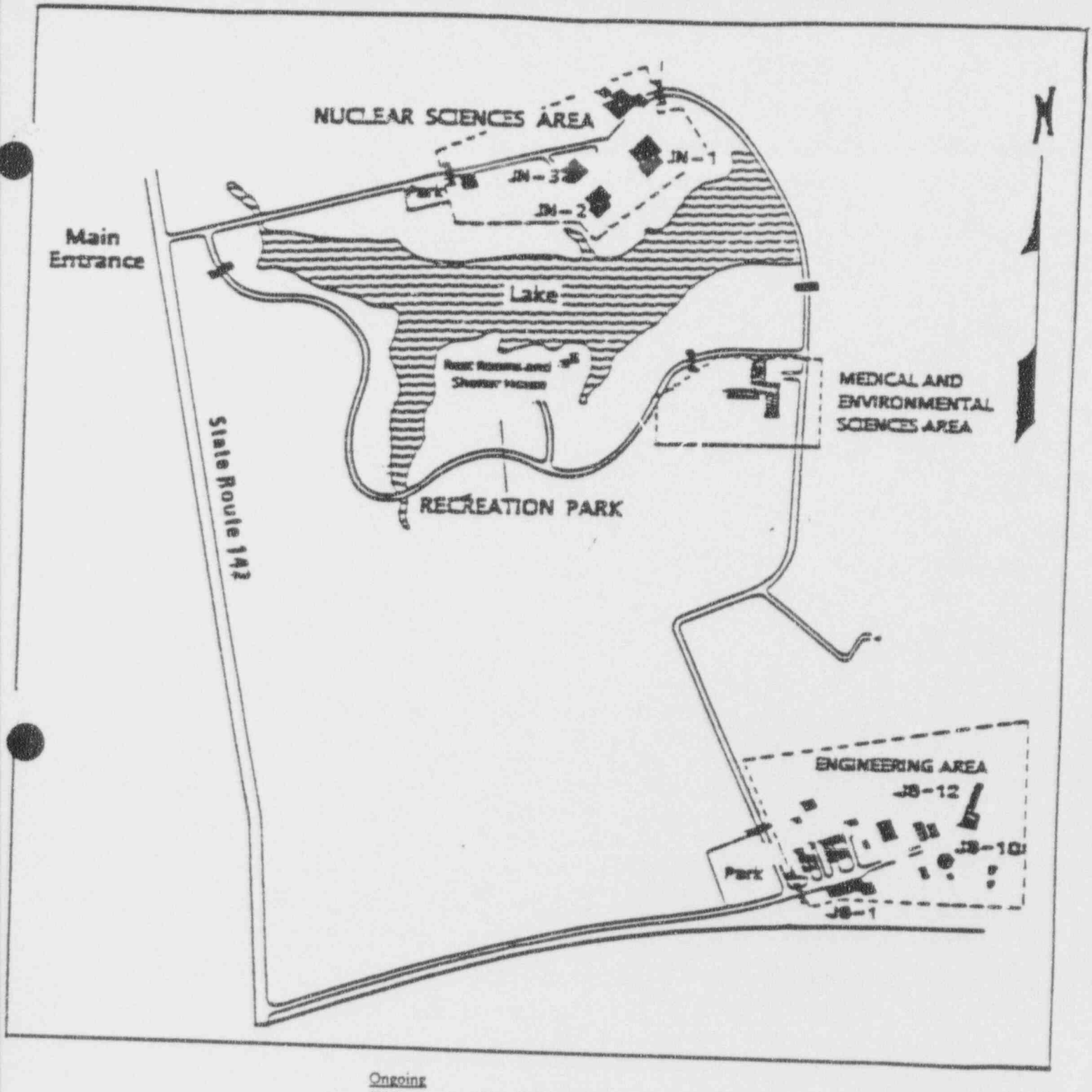
This Decommissioning Plan describes the planned decontamination and decommissioning of 15 buildings or portions thereof and possibly underlying and/or adjacent soils, which became radioactively contaminated as a result of performance of work under the U.S. Government contract. The fifteen buildings were contaminated as a result of nuclear materials research and development activities conducted for the U.S. Government and commercial nuclear facility clients [2.1,2.2]. The Battelle-owned buildings are being decontaminated at this time to make them available for unrestricted use.

Nine of the buildings are located at Battelle's King Avenue site, Columbus, Ohio (Figure 2.1), and the remaining six buildings are located at Battelle's West Jefferson site, West Jefferson, Ohio (Figure 2.2). Portions of the King Avenue site have radioactively contaminated research facilities and equipment contained in buildings which range in age from 30 to 60 years old, across the street from The Ohio State University. A moderate density residential area, the Olentangy River, and several commercial and industrial areas are within 1/2 mile of this site. The West Jefferson site consists of radioactively contaminated facilities including a decommissioned reactor building, a chemical/nuclear laboratory, and a hot cell building which is highly contaminated. The D&D of the BCO facilities will enhance environmental quality and assure public health and safety [2.3]. Battelle will perform, manage, and/or integrate the necessary D&D activities in compliance with all applicable Federal, State, and local regulations [2.4]. The Chicago Operations Office of DOE shall maintain day-by-day operational cognizance of the D&D project [2.5,2.6]. The NRC has reserved three statutory responsibilities: (1) to conduct periodic inspections, (2) to approve the release criteria used, and (3) to certify the final releases. The NRC has all rights of surveillance as agreed with DOE and Battelle [2.7] and as set forth in the SNM-7 license.

2.1.2 Objective

The overall objective of this D&D project is to return the fifteen contaminated buildings and surrounding sites to Battelle, free from radiological restrictions, at or below levels consistent with U.S. NRC [2.8] and DOE applicable requirements [2.4], and in a timely manner. These facilities are an integral part of the Battelle's ongoing R&D operations in Columbus. Several D&D alternatives were evaluated:

- Close Facilities and Continue S&M. This option involves leaving the facilities intact while continuing surveillance and maintenance (S&M) [2.9], and activities which are directed at preventing radiation exposure to workers, the environment, and the public. Accordingly, closing the facilities and continuing S&M indefinitely does not remove radioactive material from the site, in a timely manner, it therefore is not considered a feasible alternative for meeting the D&D objective of Battelle.



Ongoing

JN-1	Hot Cell Laboratory
JN-2	Administrative Building
JN-3	Decommissioned Research Reactor

Completed

JS-1	Hot Isostatic Processing Facility and Site Facilities
JS-10	High-Energy Containment Building
JS-12	High-Energy Ballistics Research Building

Figure 2.2 West Jefferson Buildings

- Perform the decommissioning operations in accordance with ALARA (as low as reasonably achievable) principles.
- Perform the technical decommissioning operations within the budget and time allocations.

To accomplish the overall objective, the proposed activities and tasks of the D&D project will include the following:

(1) Conduct pre and post D&D radiological characterization surveys of each building and the surrounding areas [2.10,2.11].

(2) Remove spent fuel fragments or fines, special nuclear and source material, low level waste (LLW), transuranic (TRU) waste, by-product material, and hazardous material required to prepare buildings for D&D.

(3) Plan, engineer, and procure equipment for the D&D tasks.

(4) Continue surveillance and maintenance of the buildings and site during D&D.

(5) Perform and/or manage D&D of 15 buildings and surrounding grounds, as necessary.

(6) Perform the necessary environmental, safety and health support functions in compliance with applicable Federal, State, and local regulations.

(7) Develop appropriate release criteria for NRC approval.

(8) Package and transport all D&D waste to an appropriate storage or disposal facility.

(9) Contract for independent radiological release surveys by an independent verification contractor (IVC).

(10) Complete restoration, as required, of buildings for structural integrity or safety.

The type of operations required to achieve the above listed objectives will vary among the buildings and the areas surrounding the buildings involved, depending on the nature of the previous radioactive material operations. The concept of ALARA dose rates for the workers is an important part of this technical objective. The details of the ALARA program are described in section 3.2. The objectives will be achieved by utilizing a suitable mix of experienced Battelle staff and subcontractors. Subcontractor assistance is described in section 2.4. Battelle has a core of staff experienced in nuclear facility operations, D&D operations, waste management, radiation protection, occupational safety and health, health physics, and environmental protection. When subcontractors are required, they will be selected based on applicable prior experience using competitive cost considerations. The number and type of subcontractors utilized will be based on the type of workers required. All workers will be

The two other buildings at the Nuclear Sciences Area are the former Critical Assembly Laboratory (JN-2) and the partially dismantled Research Reactor Building (JN-3). Both of these buildings are significantly less contaminated than the Hot Cell Building. The former Critical Assembly Laboratory was originally used for reactor critical assembly experiments, direct energy conversion experiments, experiment assembly, special nuclear materials handling, and plutonium research activities. Active nuclear experimentation in this building was terminated in 1970. A small Plutonium Laboratory previously located in this building was decontaminated and converted into the current Radioanalytical Laboratory. This building also contains administration offices and a special nuclear materials vault.

The Battelle Research Reactor (BRR) was actively used from 1956 until 1974. It was then partially dismantled. The pool liner and core hardware were removed and most of the building was decontaminated. The BRR license was then changed to a possession only under SNM-7. Since then it has been used for short term waste storage (approximately one truck load of low level waste).

The three buildings (JS-1, JS-10, and JS-12) at the Engineering Area, (the D&D was completed in 1990) were used for fuel element fabrication and ballistics studies. The Hot Isostatic Pressure Bonding Facility (JS-1) was used to fabricate military reactor fuel elements using the hot isostatic pressure (HIP) fabrication technique. The other two buildings (JS-10, JS-12) were used for studies involving explosive forming and bonding techniques, and for ballistic studies using nuclear materials. These three facilities were never operated under the NRC license. They were independently verified, and returned to BCO for unrestricted use.

Section 3.1 provides more detailed radiological history information.

2.1.3.2 Assessment of Contamination Levels

The facilities undergoing D&D can be placed in three categories based on the history of operations and the levels of contamination present: Category 1 - widely contaminated with low radioactivity levels; Category 2 - high radiation fields and extensive contamination in hot cell areas and lower levels of contamination in operating areas; Category 3 - low level contamination of isolated sections in otherwise uncontaminated facilities. The building categories are shown in Table 2.1. Contamination levels and isotopes are shown in Table 3.1. Note that all fissile material has been removed from the Battelle sites other than small laboratory samples or standards.

Category 1. Category 1 defines contamination levels which vary from low to moderately high and which are widespread throughout the building; the buildings in this category are contaminated above background levels over wide areas of floors, walls, and ceilings, and contain contaminated equipment. Four buildings (KA-1, KA-2, KA-3, and JN-3) have this level of contamination. A typical example of such a contaminated building is shown in Figure 2.3. Decontaminating this category building will potentially require isolation of the building prior to initiation of operations. Only limited and controlled non-nuclear operations are now conducted in these buildings. All of the operations unrelated to decommissioning will be relocated, and uncontaminated equipment will be surveyed and removed from the facility prior to decommissioning.

Category 2. Category 2 is the Hot Cell Facility, Building JN-1. This is the only Category 2 building to be decommissioned. The operating cells of this building have high radiation fields and extensive contamination on the ceilings, walls, and floors. The equipment inside the cell is also highly contaminated. Other areas in the building have low levels of contamination. Decommissioning of this building's hot cells will require some remote operations, and extensive radiation protection precautions. Figure 2.4 shows the floor plan of this building.

Category 3. Category 3 includes buildings KA-A, KA-4, KA-5, KA-6, KA-7, KA-9, JS-1, JS-10, JS-12, and JN-2 which are only partially contaminated and most of the contamination is fixed. Buildings JS-1, JS-10, JS-12, and KA-9 have been completed. Only controlled, non-nuclear research programs are currently being conducted in some areas of the Category 3 buildings adjacent to areas scheduled for decommissioning. Proposed decommissioning activities within or for these buildings include isolation of the areas to be decommissioned, and establishment of access control and administrative procedures to prevent the spread of contamination during decommissioning. A typical example of a Category 3 building is shown in Figure 2.5.

2.1.3.3 Planning and Assessment

Planning includes the preparation of project planning documents which will control and guide the decommissioning operations, preparation of documents to meet regulatory and institutional requirements, preparation of cost schedule and technical baseline estimates for the decommissioning operations, site characterization, and performance of operations in preparation for decontamination.

Decommissioning of each facility or major part thereof will be conducted as a separate campaign. Therefore, a planned Readiness Review [2.12] will be performed prior to decontamination operations of each campaign. The campaign-specific Readiness Review package will include, but is not limited to, the following subjects:

- Decommissioning Operations Plan
- Organization of the Project
- Decommissioning Operations Objectives
- Radiological and Chemical Characterization Report
- Safety and Environmental Risk Assessment
- Decommissioning Operations Release Criteria
- Work Breakdown Structure
- Decommissioning Operations Schedule
- Waste Management Plan
- Support Functions (QA, Health Physics, Radiological Safety Training)
- Work Instructions
- Radiation Work Permits

BUILDING JN-1
Floor Plan of the BCD Hot Cell Facility

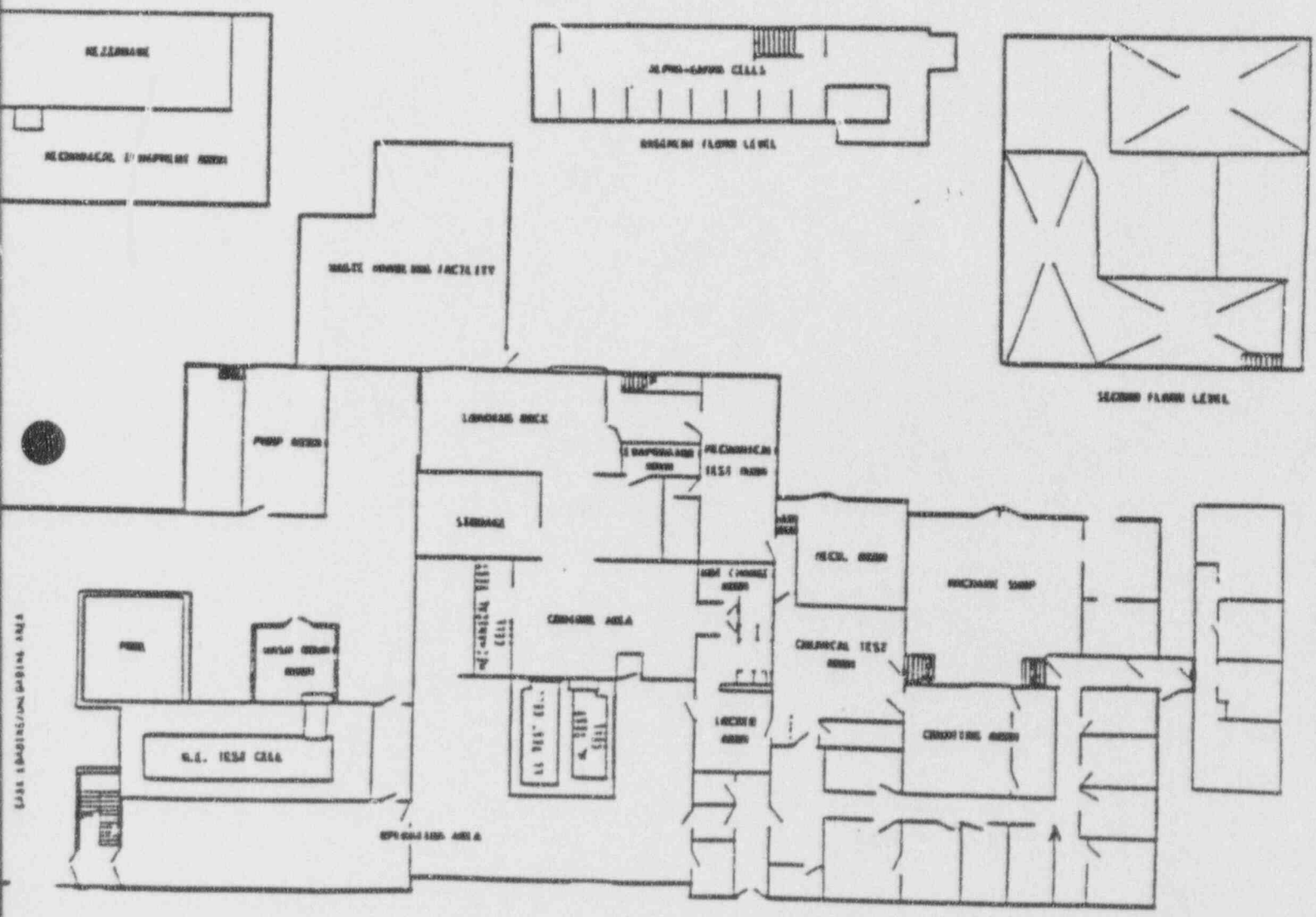


Figure 2.4 Example of Category 2 Contaminated Building

The **Site Characterization Plan** (SCP) [2.13] provides guidance for radiological characterization of locations surrounding the buildings to be decommissioned. The SCP sets forth the procedures for a detailed characterization. It includes the following subjects:

- Site Sampling Plan
  - Sampling approach for areas within, under and around buildings
  - Sample analyses
  - Reporting procedures
- Responsibility for Site Characterization.

The **Site or Building Characterization Report** [2.14] includes radiological and chemical survey data. It will be prepared for each building or area to be decontaminated. Upon completion, each area or building including areas not D&Ded will have an independent verification survey to confirm release criteria have been met.

Surveillance and Maintenance (S&M) operations are performed prior to, during, and after decontamination to assure that the contamination in the fifteen buildings remains controlled and is not inadvertently spread. S&M activities include:

- Environmental Monitoring -- An environmental monitoring program is required to assure that radioactive contamination has not escaped to the surrounding environment. The environmental monitoring includes collection and analysis of water, air, soil, vegetation, agricultural crop, and sedimentation samples from areas surrounding the Battelle facilities [2.15].

- Facility Surveillance and Maintenance -- This includes regularly scheduled inspection and maintenance of health, safety, and radiation protection equipment and instrumentation. A detailed schedule of inspection and maintenance is followed. All S&M activities are conducted under an established nuclear quality assurance program. Emergency planning, training, and drills are also conducted as part of S&M [2.16]. Repair and replacement of equipment, air and water filtration and clean-up equipment performed as required.

- Operational Health Physics -- A program of health physics radiation monitoring is conducted, including training of site personnel, posting of contaminated areas, a detailed schedule of health physics surveillance monitoring and personnel dosimetry. This health physics program is described in section 3.3.

8. Remove exposed and contaminated plumbing, hoods, ducts, and electric equipment (including surface conduits and hanging lights) and dispose as radioactive waste.

9. Decontaminate the ceilings, floors, and walls using detailed decontamination procedures as prepared based on information from the radiological characterization surveys. The principal decontamination method will be wiping and vacuuming and/or removal of surface layers from the ceilings, walls and floors. Isolation will be provided to control the spread of contamination, as well as the use of dust and liquid collection equipment.

10. Characterize and clean or remove all sumps, vertical and horizontal drain lines, and sewer lines.

11. Perform interim radiological and chemical surveys to determine the depth to which material must be removed to achieve complete decontamination consistent with the release criteria and the release procedure.

12. Perform a Planned Final Radiation Survey, including any building areas not covered in the D&D plan, and then notify DOE that the building is ready for an independent verification survey when the radiological survey indicates that the building has been successfully decontaminated and the waste removed. The independent verification contractor (IVC) who will perform an independent confirmatory survey is Oak Ridge Institute of Science and Education (ORISE).

13. Restore the building when the building is certified as releasable free from radiological restriction. The restoration operations do not constitute a radiological hazard to the workers or the public.

2.1.3.4.2 Category 2: Sequence of D&D Operations. The Hot Cell Building (JN-1) has been operated as a "closed system" with respect to release to the environment. Thus, all radioactive materials handled and processed in the building, and the associated waste generated were retained in the building. The "closed system" feature will be maintained during the decommissioning operations. The following is the general sequence of decommissioning operations:

1. Continue throughout the decommissioning operations the current, complete environmental monitoring procedures including sampling of air, water, and soil.

2. Prepare a staging area at JN-3 for handling and packaging low level contaminated equipment and waste removed during the decommissioning operations. High level waste and transuranic waste will be packaged in the hot cell.

2.1.3.4.3 Category 3: Sequence of D&D Operations. The primary concern during decommissioning operations in Category 3 buildings will be to initially isolate the contaminated areas and prevent the spread of contamination to clean areas. The following is the general sequence of operations proposed for decommissioning Category 3 buildings:

1. Relocate any staff and/or non-nuclear operations from the areas to be decontaminated.

2. Relocate or isolate all activities from the clean areas adjacent or near the contaminated areas.

3. Establish access control areas near the contaminated areas. The access control areas will provide for change rooms and showers as required.

4. Survey and remove uncontaminated items including office furniture and laboratory equipment.

5. Perform detailed radiological surveys of the contaminated areas and the equipment in those areas. This will assist in preparing the specific decontamination procedures for specific areas.

6. Prepare a staging area for handling and packaging contaminated equipment and waste removed during the decommissioning operations.

7. Remove contaminated furniture and equipment. Decontaminate at a suitable location or dispose as radioactive waste as deemed appropriate.

8. Seal all drains, vents, and other openings from the contaminated areas to prevent the release of radioactive material during these decommissioning operations.

9. Remove exposed and contaminated plumbing, hoods, ducts, and electric equipment (including surface conduits and hanging lights) and dispose as radioactive waste.

10. Decontaminate the ceilings, floors, walls, and using detailed procedures as prepared using information obtained from the radiological surveys. The principal decontamination method will be vacuum cleaning, wiping, and removal of the surface layers from the ceilings, walls and floors. Care will be taken to control the spread of contamination by isolation and use of dust and liquid collection equipment.

11. Remediate sumps, vertical and horizontal drain lines, and sewer lines by decontamination or removal.

airborne concentrations, and surface contamination will be maintained in the work area, adjacent areas, and peripheral areas to evaluate the effectiveness of contamination controls and to detect and map trends. Such preventive and mitigative measures will also prevent and control contamination transported by air movement as well as by other transfer vectors. Preventative measures to control airborne contamination include:

- Enclosure and isolation of the work areas.
- Control of traffic and movement of equipment and materials in and out of the work area enclosure.
- Ventilation of the work area to maintain the enclosed area a negative pressure with respect to surrounding areas and capture and remove from the exhausted air stream a major portion of the aerosols with standard high efficiency particulate air (HEPA) filters.
- Change areas for workers in the staging area.
- Continuous monitoring and sampling of the air in the D&D areas and in the exhaust stream.
- Use of personal dosimeters and breathing zone air samplers.
- Use of local exhaust pick up for decontamination procedures such as certain kinds of abrasive blasting, scabbling, drilling, and spalling.
- Use of a fine water spray to reduce the amount of dust which becomes airborne.
- Use of remote manipulators in the decontamination process in the Hot Cells Laboratory.
- Use of approved containers for waste transfers.

Decommissioning will be accomplished as described above to reduce risks and proceed in a safe manner.

2.1.4 Procedures

Battelle will conduct the decommissioning activities and tasks in accordance with approved procedures which are responsive to Quality Grading as outlined in QA-AP-5.1 (Preparation of Procedures), QA-AP-5.2 (Work Instructions), and QA-AP-6.1 (Document Control) and in the Quality Manual for the BCLDP. Second tier documents are prepared for each building for example, QAP-4.1 (Quality Assurance Plan for Decontamination and Decommissioning Operations in Building 6, 6G-NW Area), QAP-7.1 (Quality Assurance Plan for Decontamination and Decommissioning Operations in Building 3), QAP-11.0 (Quality Assurance Plan for Decontamination and Decommissioning Operations in Building A). A

responsible personnel. All project personnel are required to have an approved procedure before work is started and assure they have the proper version of the document. All project personnel working with a Work Instruction are required to read and document by signature that they understand the Work Instruction being performed. For more critical procedures, they must demonstrate proficiency.

Methods for document revision and accomplishing activities under approved, temporary procedures are specified in QA-AP-5.1. The life of a temporary procedure is limited to thirty days but may be extended to a maximum of sixty days. After sixty days, the temporary procedure expires or must be incorporated into an existing or new procedure. The Project Quality Manager is responsible for assuring that the temporary procedure is terminated or incorporated into an existing or new procedure.

2.1.5 Schedules

Decommissioning activities for the Battelle nuclear facilities began in June 1988 with the initiation of Planning and Assessment.

Figure 2.6 shows the baseline schedule for decommissioning each of the remaining eleven buildings and the associated soils. Development of more detailed building-specific milestones is part of the D&D planning and Readiness Review process for the individual building.

Buildings JS-1, JS-10, JS-12, and KA-9 have been decommissioned. Decommissioning of each of the remaining 11 buildings is generally independent of each other. As shown in the project schedule (Figure 2.6), the activities for each building will be parallel. Figure 2.6 indicates that the critical path for the decommissioning activities runs through completion of the building which will require the most time, Building JN-1. Specific activities and milestones for decommissioning this building as well as the other 10 buildings are being planned as part of the building-specific D&D/Readiness Review plans. Due to the nature of these buildings, and available funding, the D&D has been scheduled through 2000.

2.2 Decommissioning Organization and Responsibilities

The Department of Energy has the lead responsibility for day-to-day management of this Federally funded project. The NRC has responsibility for conducting periodic inspections; approving this Decommissioning Plan, the Financial/Assurance Plan, and the release criteria; and certifying the facilities for release. These D&D activities will be conducted and/or managed by Battelle under contract to DOE through its Chicago Operations Office. The D&D project is referred to as the Battelle Columbus Laboratories Decommissioning Project (BCLDP). Battelle will function as the decommissioning operations contractor (DOC) and will be responsible for all decommissioning operations, including procurement of appropriate subcontractors and integration of work performed. Battelle has the ultimate responsibility for complying with all the environmental, safety and health requirements of the U.S. NRC license SNM-7.

The DOE organization chart showing the lines of authority and responsibility for the project is presented in Figure 2.7.

2.2.1 Department of Energy - Chicago Operations (CH)

The DOE Project Manager, CH, (on site) is responsible for D E oversight and field management of the BCLDP. As the DOE/CH Contracting Officer's Technical Representative, he has technical and programmatic authority for overall project implementation. The DOE/CH Contracting Officer is responsible for contract administration.

2.2.2 Decommissioning Operations

Battelle will manage, integrate, perform, and subcontract the decommissioning operations, as necessary, to ensure that all activities are performed within the requirements for occupational, radiological and industrial safety, environmental protection, site security, cost and schedule baselines, and the technical objectives of the project including the approved release criteria. Battelle activities will include preparation of detailed work procedures, engineering and design functions, decommissioning activities, property and waste disposal functions, and transportation of packaged waste material to a remote disposal site. In addition, Battelle will be responsible for all on-site work performance including that of subcontractors. After the completion of decommissioning activities, a planned final radiation survey of all areas will be conducted to verify that decontamination is complete and the facilities may be released without restriction. DOE will be notified and an independent verification survey will be performed by ORISE under a contract to DOE-HQ to verify that decommissioned facilities are suitable for release without radiological restrictions. A certification package will then be submitted to the NRC for its review and final certification of facility release.

The Battelle organization for the BCLDP is presented in Figure 2.8. The primary responsibilities for safety in decommissioning operations rests with this management team. The Program Manager is Dr. Kenneth C. Brog. Dr. Brog has 30 years experience in physics and nuclear technology at Battelle including 14 years in the planning and management of nuclear projects. He has been responsible for planning and/or management of a number of major projects and is currently responsible for managing all work in nuclear D&D at Battelle Columbus Operations.

The Manager of Decontamination Operations is Virgil E. Castleberry. Mr. Castleberry has over 15 years of engineering management and project management experience at a major DOE facility. He was responsible for planning and managing decommissioning of a large plutonium processing and a tritium-contaminated laboratory just prior to joining the BCLDP.

The Manager of Regulatory Compliance, Environmental Safety and Health Oversight is Mark E. Jackson. Mr. Jackson has over 17 years experience in nuclear licensing and regulatory compliance, both from the perspective of the applicant (nuclear utilities and DOE) and the regulator (NRC). He has performed and supervised every aspect of licensing commercial nuclear power plants, including preparation of license applications, interpretation of regulatory requirements, development of technical guidance, technical specifications, review and closure of licensing issues, and review of design change packages for operating reactors.

The Quality Manager is Scott Brown. Mr. Brown has 9 years of experience with Battelle in quality programs and technical activities. The majority of Mr. Brown's experience has been quality program development, facilitation, and verification for various environmental and radioactive waste management programs. He spent three and a half years performing quality program responsibilities for the nations high-level radioactive waste repository program and various low-level waste projects. For the last three and a half years, he has been responsible for the development, performance, facilitation, and management of a compliant and effective Quality Program for all activities in the Battelle Columbus Laboratories Decommissioning Project (BCLDP).

The Manager of Safety, Health, and Environmental Support is Stephen Layendecker. Mr. Layendecker has over 11 years experience in radiation protection and regulatory compliance at major DOE facilities and commercial nuclear power plants. He is a certified health physicist.

The Manager, Remedial Action is Ronald S. Carlson. Mr. Carlson has over 25 years of experience in the construction industry including 15 years as Carpenter, Foreman, and/or Superintendent in the building trades; 6 years as Lead Construction Engineer in Construction Management at the DOE Idaho National Engineering Laboratory (including remedial action and experimental waste reduction facilities); 2 years in remedial action as Project Manager on the UMTRA project; 4 years experience as Site Manger on the Denver Radium EPA Superfund Site; and 1 year experience as Project Manager on the BCLDP Project prior to being promoted to Manager, Remedial Action.

The Manager for Decommissioning Engineering functions are being handled by Samuel Basham, PE, with technical support from Battelle corporate staff on an as-needed basis. Mr. Basham has over 35 years experience in nuclear reactor research and

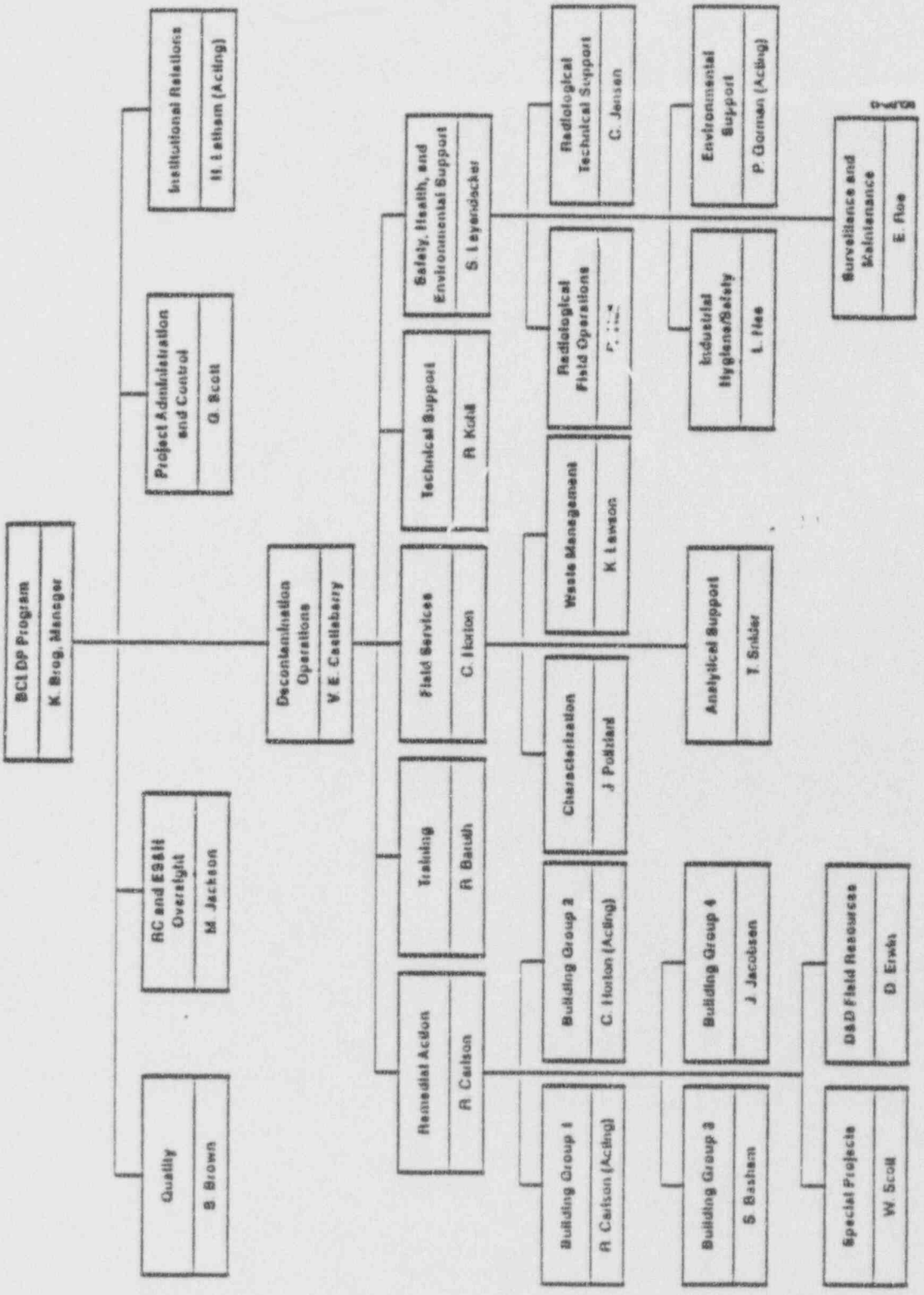


Figure 2.8 Battelle Organization Chart of Key Management Positions for the BCLDP Decommissioning Operations

2.2.3 Organization Communications

The BCLDP will require effective communications between participants for routine matters and emergency conditions. The Project Plan (Rev. 1, dated July 1991) describes the organization and communicates responsibilities for DOE-HQ and the DOE Chicago Field Office, including the onsite Project Manager. The Project Management Plan (Rev. 1, dated October 1992) describes project administration and control. It provides more specific details of the daily operations of the project.

The Battelle emergency plan and procedures for King Avenue and West Jefferson North [2.16] identifies the types of emergencies that might occur and the immediate responses to be taken. The plan also presents the emergency communications procedures to be followed. This plan is being updated. Communications with local fire, police, hospitals, and ambulance services are being formally re-established. Letters have been sent to these agencies and site visits have taken place. An emergency training drill with their participation is expected to take place in the third quarter of FY93 at the King Avenue and West Jefferson sites. This will be well before decontamination begins in FY94.

2.3 Training

2.3.1 Training Requirements

The BCLDP has adopted a policy that all personnel working on the project are required to have appropriate and verified training for the task assigned to them. The BCLDP Training Program Plan (DD-93-04) outlines the training program requirements for employees, subcontractors, consultants, visitors, and others engaged in the D&D operations [2.22]. This training program addresses health, safety, and environmental concerns for these workers and the public. It meets Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), Department of Energy (DOE), and Nuclear Regulatory Commission (NRC) requirements for handling D&D tasks in a safe and environmentally-sound manner.

The Training Program is overseen and implemented by the Training Manager, Ms. Ruth Baruth, with required input from the managers responsible for the qualification and safety of their staff. This training program meets the requirements outlined in the following procedures: QA-AP-2.3, Indoctrination, Training, and Qualification; RS-AP-3.0, Radiation Protection Training; RS-AP-4.0, Health Physics Technician Training and Qualification; QA-AP-17.1, Project Records Management System for S&M and D&D Activities; and TD-AP-1.1, The Personnel Training and Qualification Records System.

2.5 References

2.1 "Battelle-Columbus. 40 Years of Energy Research for the U.S. Government", Internal Report, Battelle Columbus Division, June 1984.

2.2 "The U.S. Government and Battelle--Partners in Nuclear Research. 1943 - Present", Report prepared by Battelle for the U.S. Department of Energy, October 1985.

2.3 "Environmental Assessment and Finding of No Significant Impact for the Battelle Columbus Laboratories Decommissioning Project", June 1990. DOE document.

2.4 Applicable Requirements List, latest revision. DOE document.

2.5 "Battelle Columbus Laboratories Decommissioning Project, Project Plan, Revision 1", July 1991.

2.6 "Battelle Columbus Laboratories Decommissioning Project, Project Management Plan, Revision 1", October 1992.

2.7 U.S. NRC, Letter Pertaining to Oversight Responsibilities and Authority on BCLDP, Charles J. Haughey, US NRC to Martin A. Langsam, DOE-CH, December 18, 1990.

2.8 "Termination of Operating Licenses for Nuclear Reactors", USAEC Regulatory Guide 1.86, June 1974.

2.9 "Battelle Columbus Surplus Facilities Surveillance and Maintenance Program Plan, Revision 1", Prepared by Battelle Nuclear Services, October 1989.

2.10 "Inventory and Radiological Survey Procedure", DD-CP-005, April 1991.

2.11 "Facility Post Decontamination Resurvey/Remonitor", DD-CP-002, May 1990.

2.12 "Decontamination and Decommissioning Operations Readiness Reviews", DD-92-04, October 1992.

2.13 "Site Characterization Plan", draft

2.14 "Radiological Characterization Plan/Equipment Survey and Identification Plan for 6G-NW".

2.15 "Environmental Monitoring Plan for the BCLDP Project", EM-QAP-1.0, Revision 1, March 1991.

2.16 "Emergency Plan and Procedures, West Jefferson North", Battelle Columbus Division Document, Revised October 1989.

2.17 "Decontamination Work Plan for Building KA-7A", DD-WP-002, January 1993 (example).

3. Description of Methods Used for Protection of Occupational and Public Health and Safety

This chapter provides a description of the methods that will be used to ensure protection of workers, the public and the environment against radiation hazards during decommissioning.

3.1 Facility Radiological History Information

Battelle has completed nearly 1000 government and commercially sponsored research projects involving nuclear materials since April 1943. A description of these projects is compiled in the first reference [2.1,2.2]. The following section of this chapter is intended to provide an overview of Battelle's involvement in this nuclear work. More detailed information is presented of the current contamination status of the King Avenue and West Jefferson sites in paragraph 3.1.2 below.

3.1.1 Overview

Battelle's first studies with atomic energy development began in 1942, on the fabrication of uranium, a metal whose properties had yet to be characterized. The scope of atomic energy research rapidly increased after 1954, when the Atomic Energy Commission (AEC) lifted restrictions on atomic energy research/development. Battelle's accomplishments during the war years helped to make it possible to build and operate plutonium producing reactors, not long after the feasibility of the chain reaction had been demonstrated. Several different types of reactor systems were being assessed by the early 1950s.

Nuclear-related research was greatly expanded at Battelle in the decade after World War II. Development work on extractive metallurgy and plant corrosion resulted in an ion-exchange process which is the basis for recovery of most of the world's uranium. Extensive work was performed on alloy and fabrication process development, corrosion chemistry studies, and engineering analyses for the Naval Reactor Branch via the Naval Reactor Program, beginning in the early 1950s. Reactor development was the main research theme throughout the first 20 years, and dominated Battelle's research and development program.

The very nature of research being performed made it mandatory that a remote handling facility be built. Thus in 1955, Battelle expanded the existing nuclear facilities by building the first privately-owned nuclear research center in the world. This facility -- the Nuclear Sciences Area, located at the north end of the West Jefferson site, included a research reactor, critical assembly facility, hot cells, and later a plutonium laboratory which has since been fully decommissioned. At the south end of the West Jefferson site, several autoclaves were constructed, for use in hot isostatic pressing, a Battelle-developed technique for fabricating nuclear reactor fuel elements. Experiments connected with the radiation stability of materials were conducted in the Hot Cell Facility. Evaluation of these experiments has formed the basis for developing better nuclear fuels, control rod materials, and reactor

TABLE 3.1. SUMMARY OF RADIOLOGICAL CONTAMINATION IN THE BATTELLE FACILITIES

Building	Type of Activity/Areas	Use	Survey Instrument Reading (dpm/100 cm^2)	Estimated Contamination Inventory (Year of Inventory)	Radioisotopes	Location*/ Type of Contamination
A	Misc R&D/ First, fourth floors	Encapsulation of highly enriched U for ATR fuel elements; pilot plant operation	1.5 K - 200 K	10^4 Ci ('73)	U, Th, daughters	Drain system
1	Misc R&D/ First floor	Uranium ore processing; ore beneficiation studies	0.5 K - 10 K	0.3 Ci ('84)	U, Th, daughters	Drain system, equipment, exhaust stack and ducts, piping (sludge)
1	Foundry	Processing of ore (tons)	1 K - 15 K	2.0 Ci ('84)	U, Th, daughters	
2	Metal Working Lab	Ore processing (tons); metal working	1 K - 4 K	< 1 Ci ('84)	U-238, daughters; U, Th, daughters	Trenches (debris), piping (sludge), equipment, debris, sludge
2	Welding Lab	Natural, enriched, depleted U welding and fabrication	3 K - 15 K	10^3 Ci ('84)	U, Th, daughters	Piping (sludge), trench (debris), equipment, stacks

TABLE 3.1. (Continued)

Building	Type of Activity/Areas	Use	Survey Instrument Reading (dpm/100 cm^2)	Estimated Contamination Inventory (Year of Inventory)	Radioisotopes	Location*/ Type of Contamination
4	Radiochemistry Laboratory	Radiochemical analyses	ND	< 1 Ci ('84)	U, MFP, daughters	Residual activity in remaining sections of drain system
4	Misc Labs/ Second, fourth floors	Metallography; encapsulation facility	50 K (localized)	0.1 Ci ('84)	U, Th, daughters; MFP	Piping (sludge), trench (debris), equipment
5	Machine Shop	Machining and grinding of natural, enriched, depleted U; beryllium machining	1 K - 30 K	< 1 Ci ('84)	U, Th, daughters; MFP	Trench (debris); drain lines, equipment
5	Coating Lab	Coating	6 K - 10 K	< 0.1 Ci ('84)	U, Th, daughters; MFP	Piping (sludge); equipment, exhaust ducts, stacks
5	Misc R&D/ First, second floors	Americium processing; corrosion	2 K - 40 K	< 1 Ci ('84)	U, Th, daughters	Piping (sludge)

TABLE 3.1. (Continued)

Building	Type of Activity/Areas	Use	Survey Instrument Reading (dpm/100 cm²)	Estimated Contamination Inventory (Year of Inventory)	Radioisotopes	Location*/ Type of Contamination
JN-1	Hot cells	Fuel element development; examination of irradiated fuel; criticality experiments	ND	6,000 Ci ('89)	MFP; U, Th, activation products (AP); Co 60	Drain lines (sludge), closed tank (water), equipment
JN-2	Former critical assembly lab; Accountability Lab; Radio-analytical lab	Fuel element development; U-235, plutonium storage; radio-chemical analyses	ND	<1 Ci ('84)	TRU, MFP, AP	Tanks (closed); stored water; drain lines (sludge); trench (debris)
JN-3	Retired research reactor	Reactor studies; material irradiations	ND	ND	TRU, MFP, AP	Piping, trench base of containment), external hold-up tank (water); external drain system; drainage system (sludge)

* Building surface contamination is common to all buildings.

ND = not determined.

Buildings 6 and 7 (Chemistry Buildings). Analytical chemistry activities in support of the DOE/Navy program took place in these buildings. The work involved alloy studies, corrosion research, chemical and instrumental analyses. Low levels of contamination exist in the ground and first floors of Building 6, and in the first through fourth floors of Building 7. Contamination also has been detected in the drain system for these buildings. The contamination in both buildings is due to uranium and thorium.

Building 9 (Mechanical Engineering Building). Research programs were conducted in Building 9 for AEC/ERDA/DOE involving natural and depleted uranium. Minimal surface contamination remained in one area of the ground floor and drain lines were slightly contaminated with uranium and thorium. A laboratory area on the mezzanine contained contaminated hoods and duct work which were removed. This building has been decontaminated and released.

3.1.2.2 West Jefferson Site

Building JN-1 (Hot Cells). JN-1 was constructed to support fuel development research for the AEC. The facility was initially used for hot cell examination of fuel specimens which had been irradiated in the Battelle Research Reactor. Subsequent work involved examination of fuel from commercial power reactors in support of DOE programs. Due to the nature and extent of contamination within the hot cell area, a formal radiological survey has not been performed. Extensive contamination from transuranics, fission products, activation products, uranium and decay products, and Co-60 exists throughout the hot cell laboratories.

Building JN-2 (Former Critical Assembly Laboratory). This building was used for a zero power organic-moderated critical assembly and other criticality experiments. Subsequently, JN-2 housed a small plutonium laboratory, an instrument laboratory, and currently a radioanalytical laboratory for the D&D program. The building also contains a storage vault formerly used for storage of plutonium and highly-enriched uranium. Contamination exists in those areas and in an underground storage tank and its associated hot drain system. The plutonium laboratory was decontaminated and converted into the radioanalytical laboratory.

Building JN-3 (Reactor Building). Building JN-3 housed a research reactor which was operated in support of fuel development programs for the AEC. This reactor was partially decommissioned in the mid seventies and retired. Subsequently, the building was used to store waste generated from previous D&D activities in the JN-2 Plutonium Laboratory and another Plutonium Laboratory (JN-4) at the same site. TRU, MFP, and activation products are present, either as surface contamination, or in sludge/water/soil media in drain lines and around the containment building itself as a result of former reactor operations.

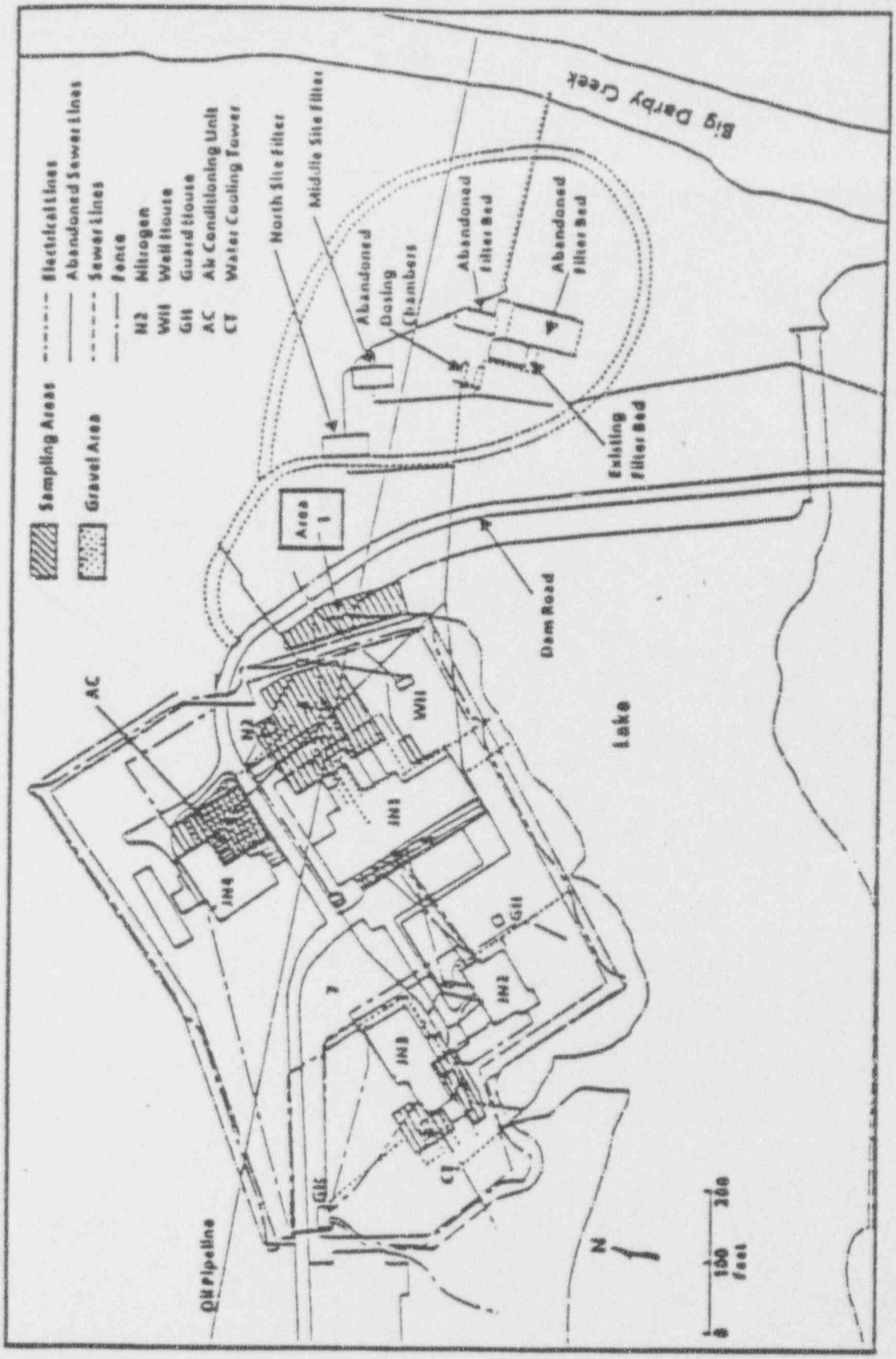


Figure 3.1 Environmental Monitoring at the West Jefferson Nuclear Sciences Area Showed Evidence of Soil Contamination in the Proximity of the Abandoned Filter Beds and the Storm Sewer Outfall (Area 1)

As required, the Battelle Responsible Officer notified the NRC on November 11, 1977 [3.5] within two days after receiving the results of the evaluation. Since no radioactivity was released during this occurrence, there is no residual contamination due to this specific incident.

The other noncompliance incident reported to NRC involved a release of airborne radioactive material within the Hot Cell facility and subsequent surface contamination. This occurred at the Hot Cell facility on May 3, 1980, during unloading operations of a failed spent fuel assembly received from the Connecticut Yankee Atomic Power Company. There was no release of radioactive material from the building. The data from bioassay procedures, including in-vivo counting, have established that resultant radiation exposures were well within prescribed standards as set forth in 10 CFR Part 20. Pulmonary depositions were a fraction of a percent of the permissible body burden.

An evaluation of this deviation in accordance with 10 CFR Part 21 procedures determined that this incident was reportable to the NRC as a defect in that it could have created a substantial safety hazard to staff in the area and the environment. Accordingly, the Battelle Responsible Officer notified the NRC on July 18, 1980 [3.6] within two days of the evaluation. However, the surface contamination was largely removed following the occurrence and subsequent monitoring has shown no significant residual contamination.

3.1.4 Radiation Levels

The 1984 radiological survey of the facilities showed that with the exception of the Hot Cell (Building JN-1), the contamination was widespread but that the radiation levels were low, in the range of 0.1-0.2 mR/hr (beta-gamma). Although no measurements were made in the hot cells as part of the 1984 survey, the presence of radioactive materials currently stored in the cells and contamination from past operations indicates high radiation fields within the cells and in the controlled-access areas. The operating areas outside the cells have average radiation levels of less than 0.5 mR/hr. Table 3.1 shows radiation levels reported in the 1984 survey of the building. Radiation levels will be continuously monitored and all operations will be performed in keeping with the ALARA considerations described in the next section during decommissioning operations in the hot cells and other buildings.

3.2 Ensuring Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA)

Ensuring occupational radiation exposures, both internal and external, are as low as reasonably achievable is accomplished through an integrated radiation protection program at BCLDP [3.7]. Project management, with a mandate and commitment from the Battelle Chief Executive Officer and senior management, aggressively promotes a policy of ALARA among project staff [3.8]. A thorough approach to ALARA is accomplished through a formal procedure-based program administered and implemented through the Safety, Health and Environmental Support (SH&ES) department [3.9]. Project staff is encouraged to actively participate in the ALARA process through suggestions, review and feedback

During jobs involving exposure to radioactive material, supervisors make regular observations of work in progress to ensure the planned exposure reduction techniques are implemented and to identify other ways to further reduce exposures.

It is the policy of the BCLDP that ALARA is an individual as well as a collective philosophy in which training equips the staff with the tools to have a successful program and management commitment promotes the use of those tools. Training is described in section 2.3.

Supplemental implementation is accomplished through other administrative and operating procedures, training, oversight activities and management direction.

3.3 Health Physics Program

3.3.1 Radiation Protection Program

The BCLDP Radiation Protection program is an element of the BCLDP Safety, Health and Environmental Support Staff (see Figure 3.2). The SH&ES manager is the functional Radiation Protection Manager reporting to the BCLDP Decontamination Operations Manager. The Battelle Radiation Safety Officer, representing the Battelle Chief Executive Office, provides oversight in matters concerning license conditions.

Reporting to the SH&ES manager are the managers of the two sections of Health Physics; the Radiological Field Operations Manager and the Radiological Technical Support Manager. The section represented by the Field Operations Manager consists of Operational Health Physics and Health Physics Support. The section represented by the Technical Support Manager consists of Dosimetry, ALARA programs, and Technical Support. The biographical information for the SH&ES Manager, Field Operations Manager, and Technical Support Manager is shown in Attachment 4.

Within each of the two sections of Health Physics, further division of authority and responsibility is provided through the HP Shift Supervisors, Dosimetry Administrator, ALARA Coordinator, and Lead Technicians (see Figure 3.3).

Detailed discussions of each area of the Health Physics program are in the document "Radiation Protection Program for the Battelle Columbus Laboratories Decommissioning Project".

Figure 3.3 Health Physics Organization

Table 3.3 Responsibilities and Reporting Requirements for Health Physics Support

	Instrumentation	RWP	Respiratory Protection	Training	Source Control	Document Control	Procurement
Responsibilities	Calibration, issue, use, repair, records and recall of all Health Physics Instrumentation	Generation, maintenance and use of all Radiation Work Permits	Storage, selection, issue, and maintenance of all respirators and breathing air systems and Fit Testing	Scheduling of personnel training and maintenance of personnel training records	Inventory, issue, leak testing and accountability of all project radioactive sources	Management of all Health Physics records	Ordering, inventory and maintenance of minimum quantity levels of all HP equipment and consumables
Reporting Requirements	Reports to Support Shift Supervisor	Reports to Support Shift Supervisor and Operations Shift Supervisor	Reports to Support Shift Supervisor	Reports to Support Shift Supervisor and works closely with the Project Training Coordinator	Reports to Support Shift Supervisor and works with RSO Group	Reports to Support Shift Supervisor and works with Project Records Management Group	Reports to Support Shift Supervisor and works closely with Battelle Purchasing Department

The ALARA coordinator, in addition to his/her formal responsibilities promotes the ALARA philosophy to the project staff and management. Further details of the ALARA program are described in section 3.2.

3.3.3.3 Technical Support

The responsibility for technical support in the areas of dose evaluations, program and equipment evaluations, and technical basis documents is managed by the Technical Support Manager (Figure 2.8). Resources are provided by the staff and management of the SH&ES department on an as needed basis. Subject expertise is provided, when necessary, from outside consulting firms.

Performance tracking and awareness reporting are also provided to the project by the Technical Support Manager.

3.3.4 Programs

3.3.4.1 Respiratory Protection

The BCLDP respiratory protection program [3.19] is based upon the guidance provided in NUREG 0041 [3.20]. Strict compliance to NIOSH and NRC requirements provides the project with a reliable, high quality program of respiratory protection.

The respiratory protection program provides training, equipment, and fit testing to all project personnel. Also, ventilation and engineering controls are provided by procedural requirements [3.21] based upon a strong admonition by project management to use these systems prior to the use of respirators.

Controlling airborne radioactivity at its source is the goal of the respiratory protection program [3.22]. Through the application of engineered controls, decontamination, ventilation systems and personnel training, the use of respirators can be minimized.

Each type of respiratory protection device used by BCLDP is controlled by its own use and maintenance procedure [3.23-3.26]. Selection of the devices for specific purposes is also procedure governed [3.27].

The Respiratory Protection section issues respirators to individuals for one time use. Each respirator issued is sealed in a clear plastic bag with a "Cleaned and Inspected" certification provided.

It is the procedurally mandated policy of BCLDP that personnel wearing respirators will have line-of-sight supervision by a qualified health physics technician in all cases.

Dedicated breathing air systems supplying Grade D air are also in use [3.28]. Use of breathing air is based upon strict compliance with NUREG 0041 and the device's NIOSH certification requirements. Normally, air supplied bubble hoods with continuous flow are the only type of supplied air respirators in use at BCLDP.

Table 3.5 Calibration Frequency

	SELECTION CRITERIA	PURPOSE	CALIBRATION SPECIFICATION	PERFORMANCE TESTING CRITERION	SENSITIVITIES
Bicron & RSO 50 Eberline RO 20 Bicron RSO 5 and RSO 5 Eberline RO 20	1. Tissue Equivalent Air Ion Chambers 2. Proven dependability 3. Energy independence 4. Linear response 5. Beta/Gamma measurement capability 6. Portable	Performance of exposure rate measurements to comply with DOE Order 5480.11 and 10 CFR 20	HP OP 101 Frequency - Every 6 months Calibrated to NIST traceable sources (CS-137 and depleted U-238) to 2 points on each scale	- Daily or prior to use - One point on each scale ± 10%	Beta and gamma radiation RSO 5 - 0.2 to 5,000 mR/h RSO-50 -0.2 to 50,000 mR/h RO-20 - 0.2 to 50,000 mr/h Linear response from 70 kev to 10 Mev
PAC-4G W/AC21B	1. Gas proportional 2. Response to alpha and beta 3. Good gamma rejection 4. Good response to very low energy beta (C-14) 5. Audible response 6. Portable	Performance of direct measurements of alpha and beta emitting isotopes on equipment and building surfaces	HP OP 103 Frequency - every 6 months Calibrated to NIST traceable Pu-239 standards. Beta response is verified but not quantified	- Daily or prior to use - One point on each decade ± 20%	Quantitative alpha-response over full energy range Qualitative beta response from energies of C-14 to Sr/Y-90
NE Technologies Delta & Electra	1. Phoswich detector 2. Integrate/scaler modes 3. Audible response 4. Two channel (alpha & beta) 5. Good gamma rejection 6. Good response to Th & U beta energies	Performance of direct measurements of alpha and beta emitting isotopes on equipment and building surfaces Replaces the PAC-4G	HP OP 123 Frequency - every 6 months Calibrated to NIST traceable Pu-239 and Tc-99 standards	- Daily or prior to use - Qualitative hourly when performing release surveys - One point on each channel ± 10%	TC-99 - 10%, 4 π Pu-239 - 15%, 4 π
Ludlum 2929	1. Phoswich detector 2. 2 channel (alpha & beta) scaler 3. Low minimum detectable activity values 4. Threshold and window variable setting capability 5. Reliability 6. Ease of calibration	Performance of smear and air sample counting	HP OP 105 Frequency - Every 6 months Calibrated to NIST traceable sources (Pu-239 and Tc-99)	- Daily or prior to use - MDA daily - Background frequently each day	Tc-99 15%, 4π Pu-239 35%, 4π

Table 3.6 Instruments

Instrument	Use	Procedure
Ludlum M-77 Stretch Probe	Extendable GM detector	HP-OP-102
F&J High Volume Air Sampler	Air sampling 4-10 CFM	HP-OP-115
SAIC Radeco High Volume Air Sampler	Air sampling	HP-OP-115
Ludlum 125 & 19 Micro-R Meter	Low level gamma exposure rates	HP-OP-119
F&J Low Volume Air Sampler	Air sampling 2 CFM	HP-OP-117
Eberline RM-14	AC powered stationary GM "frisker"	HP-OP-121
Eberline 6112B Teletecter	Extendable GM detector	HP-OP-125
Alnor Alarming Dosimeter R-100	Dose monitoring device	HP-OP-143
Buck Lapel Air Sampler	Breathing zone air samples	HP-OP-145

3.3.4.3 Hot Particle Control

The BCLDP hot particle control program is based upon the guidance described in the NCRP Report No. 106 [3.32] and proven programs from the commercial nuclear power industry. Compliance with DOE Order 5480.11 and 10 CFR 20 concerning exposure to hot particles is required by BCLDP health physics. Discussion of the hot particle control program is found in the document "Radiation Protection Program for the Battelle Columbus Laboratories Decommissioning Project, Section 2.4" and in procedure HP-OP-201, "Hot Particle Control" [3.33].

3.3.4.4 Air Sampling

The BCLDP air sampling program is based upon the requirements of DOE Order 5480.11 and 10 CFR 20. When conflict between these two documents is encountered, as in the case of some derived air concentration (DAC) values, BCLDP uses the more restrictive value.

Work place air monitoring is classified by the purpose of the sample as either "breathing zone" or "general area". Because of the very low DAC values for Th-232 and Pu-239, 300 ft^3 samples are desired when sampling.

Further discussion concerning contamination control may be found in:

"Radiation Protection Program for the BCLDP, Section 3.5"
HP-OP-012, "Posting and Access Control"
HP-OP-201, "Hot Particle Control".

3.3.4.7 Radiation Work Permits

The BCLDP Radiation Work Permit Program is based upon compliance with "U.S. DOE Radiological Control Manual, Article 321" [3.37].

Radiation work permits (RWPs) are required under the following conditions:

- Entry into any posted "Radiological Area"
- When work in a controlled area involves exposure greater than 0.5 mR/hr
- Transferring any source of non-exempt quantity or concentration
- Health physics determines that a situation warrants radiological controls in the form of an RWP.

Further discussion of RWPs may be found in:

"Radiation Protection Program for BCLDP, Section 6.6"
HP-AP-1.0, "Issue and Use of Radiation Work Permits".

3.3.4.8 Surveillance and Maintenance

The BCLDP Health Physics Surveillance and Maintenance Program is based upon compliance with 10 CFR 20.1501 and DOE Order 5480.11. Frequencies are based upon guidance found in the document INPO 88-010, Chapter VI, "Control of Radioactive Contamination" and Chapter III, "External Radiation Exposure" [3.38].

Further discussion of the surveillance and maintenance program may be found in procedure HP-OP-017, "Health Physics Routine Surveillance" [3.39].

3.4 Contractor Personnel

Contractor personnel working on the decommissioning project shall comply with the requirements of the project as described in the upper-tier documents. These documents include the Radiation Protection Program Plan, Occupational Safety and Health Program Plan [3.41], and this Decommissioning Plan. BCLDP will utilize two basic approaches to contractors to ensure their health and safety:

(1) The contractor will fall completely under the BCLDP program and perform work using BCLDP procedures, as described in the upper tier documents,

or

(2) The contractor will fall under the BCLDP upper-tier program requirements but perform work using their own procedures with possible supplementation by BCLDP procedures.

In the first approach, there is no difference between the performance of contractor and BCLDP personnel. In the second approach, there will be differences but the overall safety margin will be the same for both groups. The second approach requires BCLDP to review a contractor's program/procedures to predetermine acceptability.

BCLDP will provide oversight of all contractor personnel and activities to ensure compliance with BCLDP requirements.

3.5 Radioactive Waste Management

Waste management activities of the BCLDP will be conducted in accordance with the BCLDP Waste Management Plan [3.42] and supporting procedures. The waste generated as a result of decontamination and decommissioning (D&D) of the remaining eleven buildings and their surrounding earth/soil will be in accordance with applicable NRC, DOE, and State of Ohio requirements. Waste generated as a result of D&D activities will be building rubble, soil, and miscellaneous contaminated material. The contaminants will be uranium, thorium, mixed fission products, and transuranic isotopes. The concentrations of the contaminants have not been fully determined.

Since, for disposal purposes, all of the radioactive contamination being addressed by the BCLDP is owned by the DOE, waste materials generated as a result of these D&D operations will be disposed of at DOE-owned and/or DOE-approved disposal facilities. Project management of the BCLDP is illustrated in Section 2.2, "Decommissioning Organization and Responsibilities" (see Figure 2.8).

immobilizing agents such as Aquaset. Alternatively, an extruder-evaporator solidification method may be used. With an extruder-evaporator, a volume reduction factor of 8 or more can be expected. If cement is used, the resulting volume of solidified waste will be about 2 times greater than the volume of the original liquid waste residue.

As with D&D generated liquids, spent fuel pool water will be evaporated following extended filtration. Liquids from drains, pipes, and sumps will be collected and solidified or incinerated. Contaminated hydraulic oil will be solidified or incinerated. Contaminated mercury, if found, will be packaged in suitable containers for shipment and disposal as mixed hazardous waste.

3.5.4. Release for Unrestricted Use

Much of the waste generated by D&D activities will be evaluated for decontamination. Standard methods of decontamination of surfaces will be applied to minimize waste volumes. Surfaces that have been decontaminated will be surveyed for unrestricted use. Radiological surveys will be performed by qualified technicians using approved procedures (see list of approved procedures in Attachment 3). Material such as soils and building rubble will also be surveyed to ensure that adequate decontamination efforts have been applied. Materials surveyed for unrestricted use will be released in accordance with NRC approved release criteria based on the Surface Release Criteria Technical Basis Document and the Volumetric Release Technical Basis Document (Attachments 1 and 2).

3.5.5 Transportation and Disposal

Transportation of hazardous materials will be in accordance with Title 49 Code of Federal Regulations (49 CFR) [3.44]. Packaging requirements beyond 49 CFR will be in accordance with approved DOE disposal site requirements as stated in specific BCLDP Waste Certification Plans.

Final disposal of waste generated as a result of BCLDP D&D activities will be at DOE-owned and/or DOE-approved facilities. These disposal facilities may require specific waste certification plans to be developed by the BCLDP prior to shipping waste materials for processing (volume reduction) or disposal. Waste certification plans will be developed by the BCLDP and approved by the disposal sites prior to shipping waste materials. The waste certification plans will meet Federal, State, and disposal site criteria to ensure proper disposal for BCLDP waste materials.

3.20 NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials"

3.21 "Air Sampling and Analysis", HP-AP-11.0

3.22 "General Procedure for Operating a Continuous Air Monitor (CAM)", HP-OP-015, May 1990

3.23 "Use of Filter Type Respirators", RS-OP-004, July 1992

3.24 "Use of the Powered Air Purifying Respirators", RS-OP-006, July 1992

3.25 "Use of the Self-Contained Breathing Apparatus", RS-OP-008, July 1992

3.26 "Use of Supplied Air Bubble Hoods", RS-OP-010, August 1992

3.27 "Use of Breathing Air Systems", HP-OP-029, September 1992

3.28 "Certification of Grade D or E Breathing Air", RS-OP-016, October 1992

3.29 ANSI N-323, "Radiation Protection Instrumentation Test and Calibration Report"

3.30 Regulatory Guide, Division 8-OP-032-5, "Test and Calibration of Radiation Protection Instrumentation"

3.31 "Control of Measuring and Test Equipment and Instruments", HP-AP-29.0, Revision 1, November 1992

3.32 National Council of Radiation Protection and Measurements, Report No. 106, "Limits for Exposure to "Hot Particles" on the Skin", December 1989

3.33 "Hot Particle Control", HP-OP-201

3.34 "Posting and Access Control", HP-OP-012

3.35 "Access Control of Visitors", HP-AP-23.0

3.36 Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors"

3.37 "DOE Radiological Control Manual"

3.38 INPO 88-010, "Good Practices Manual"

3.39 "Health Physics Routine Surveillance", HP-OP-017

3.40 "Release of Materials from Controlled Areas", HP-OP-011

3.41 "Occupational Safety and Health Program for BCLDP", DD-93-01, December 1992

4. Planned Final Radiation Survey

Upon the completion of D&D activities in an area/building, a Planned Final Radiation Survey (PFRS) will be conducted to verify that the decommissioning objectives have been met for all buildings, parts thereof, and associated grounds being released. The PFRS will be prepared as a BCLDP Work Plan and will be specific for each area/building. Where appropriate, based on process knowledge and/or characterization information, the PFRS will be a statistical survey of the D&D area. In all cases, it will utilize the same basic methodologies as the site characterization processes and equivalent personnel, instruments, procedures, grid patterns, fixed reference locations, radioanalytical supports, and management review will be utilized.

To guide the PFRS, the BCLDP has prepared and issued procedure DD-CP-002, "Facility Post-Decontamination Final Status Survey". The latest revision of this procedure has been included as Attachment 5. This procedure will be used to develop the specific BCLDP Work Plan. As stated previously (Section 2.1.2.1) the facility will meet the release criteria for unrestricted use as a final status after decommissioning.

4.1 References

4.1 Annex C Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, August 1987.

5. Funding

Decommissioning of these facilities will be conducted under a cost share agreement with the U.S. Department of Energy (DOE), under which DOE is contractually obligated to fund 100 percent of the pre D&D Surveillance and Maintenance costs and 90 percent of all other D&D costs. Radioactive waste from the BCLDP will be disposed of at DOE-owned and/or DOE-approved disposal sites. The BCLDP is included in DOE's Environmental Restoration and Waste Management Five Year Plan [5.1] and DOE has approved the technical, cost and schedule baseline for completion of all facilities. Decommissioning costs, including decontamination and waste disposal, are estimated to be $149 million dollars of which $39 million dollars have already been spent through FY 1992. Final cost estimates for each building will be developed as the building characterizations are completed. The Certification for Financial Assurance for the D&D project is currently being completed and will be transmitted to the NRC when finalized.

5.1 References

5.1 Environmental Restoration and Waste Management. Five-Year Plan, Report DOE/S-070, U.S. Department of Energy, September 1989.

6. Physical Security Plan and Material Control and Accounting Plan Provisions in Place During Decommissioning

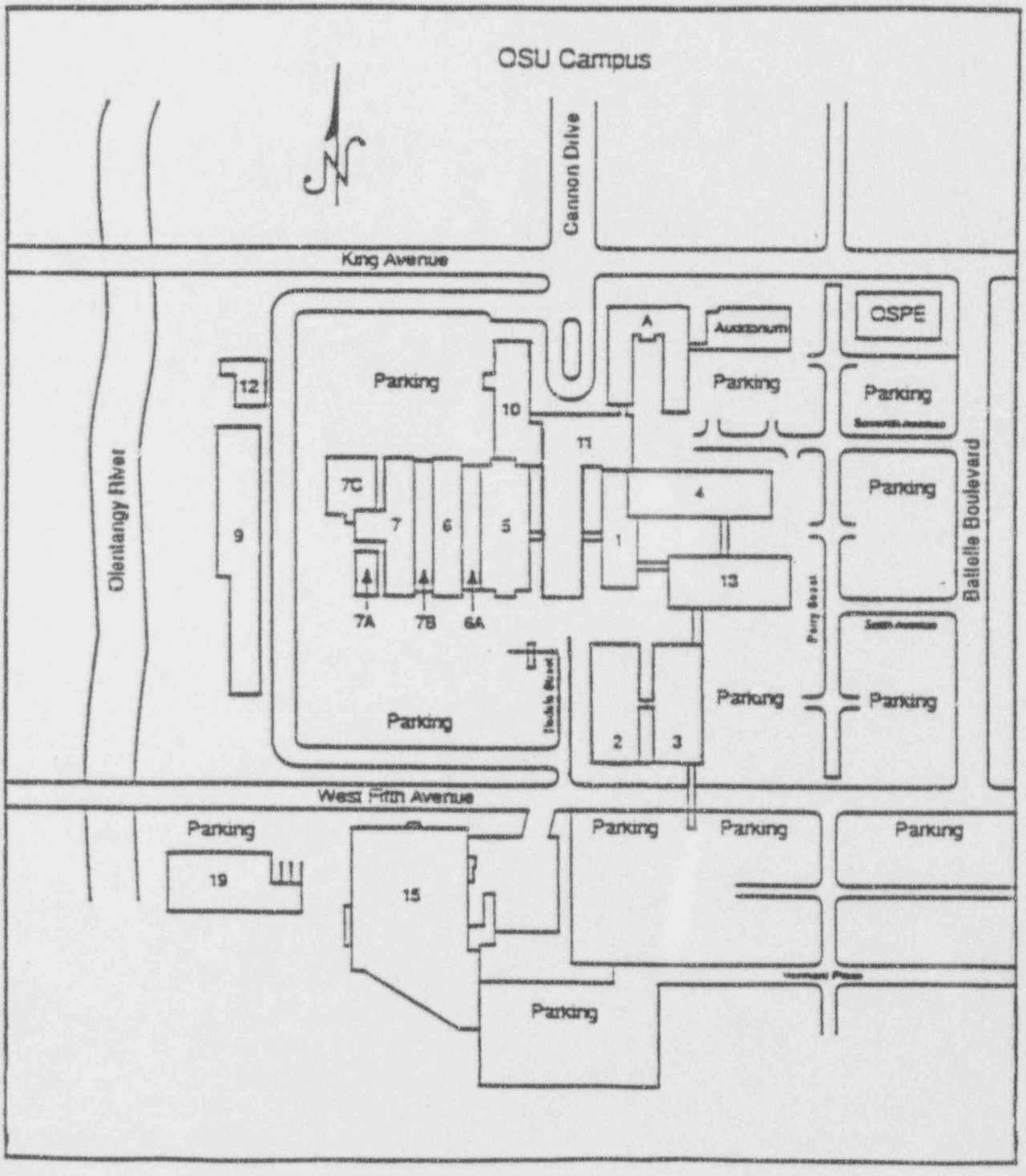
This section is no longer applicable since the requirements for maintaining the NRC approved physical security plan and special nuclear control and accounting plan was removed when the SNM inventory held under the license was shipped off-site.

APPENDIX F

FIGURES AND ATTACHMENTS

FIGURE I

KING AVENUE



BATTELLE KING AVENUE LABORATORIES

FIGURE II

WEST JEFF SITE

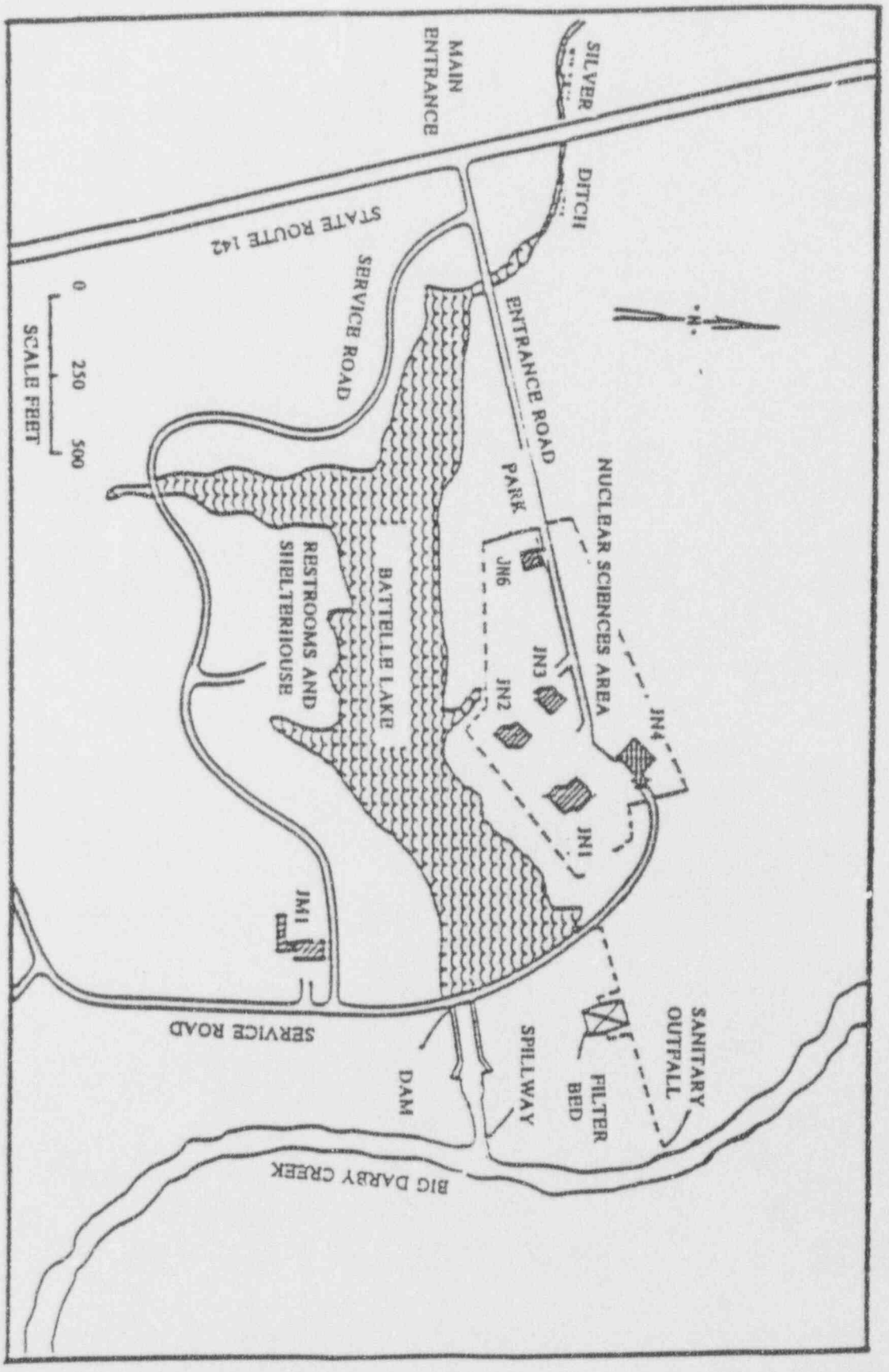
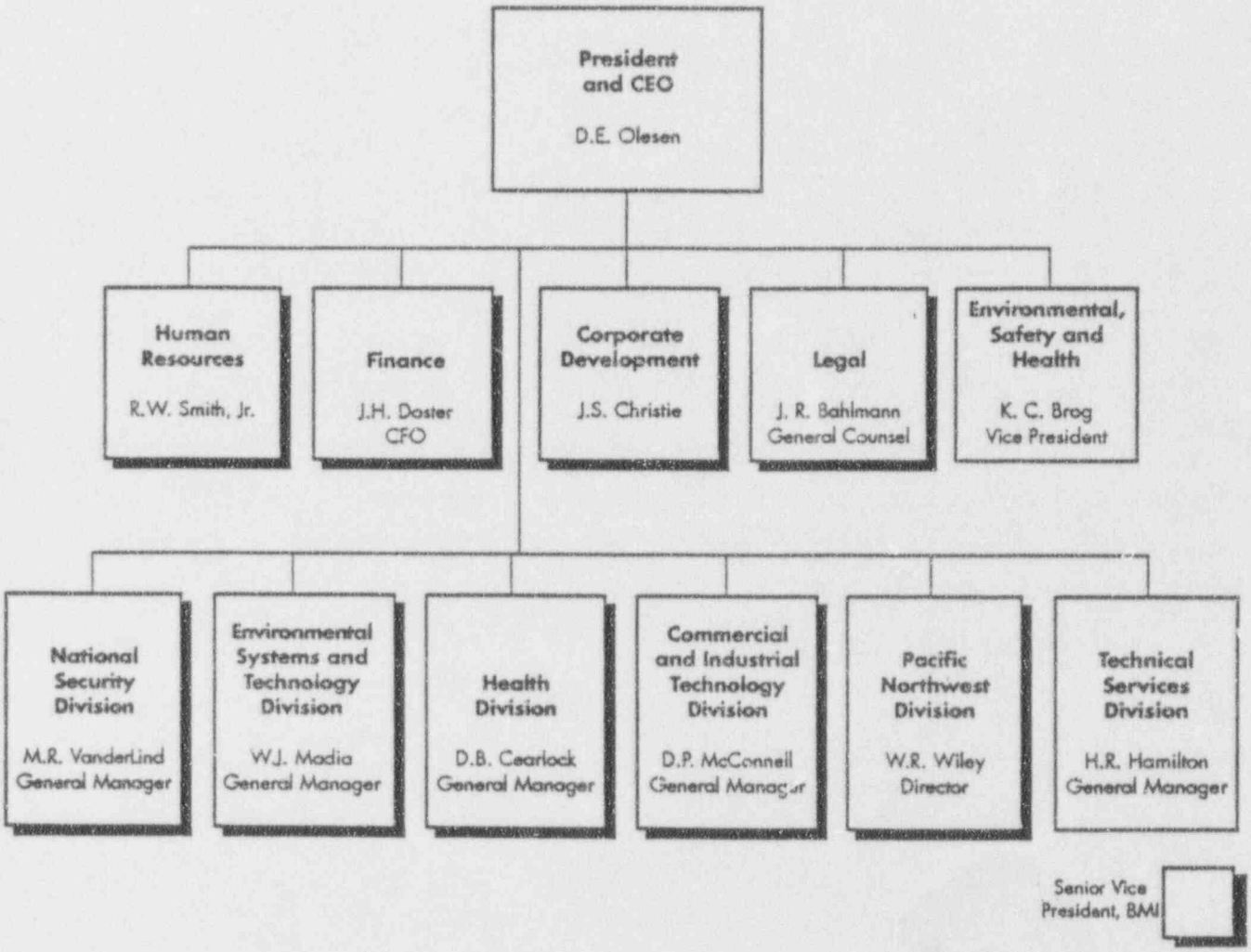


Figure III

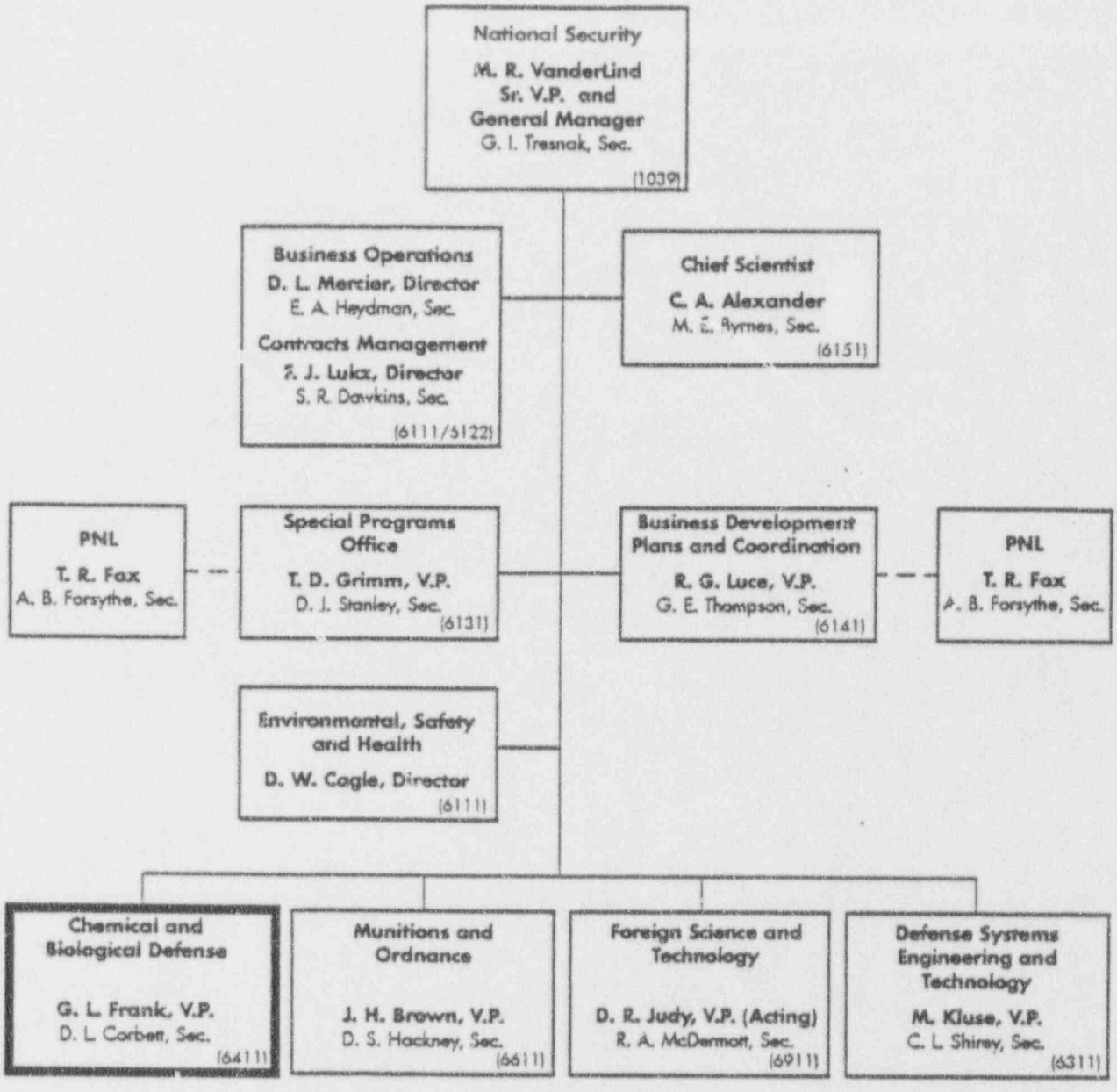
Battelle Organizational Structure



12/93

Figure IV

National Security Division



Environmental Systems and Technology Division

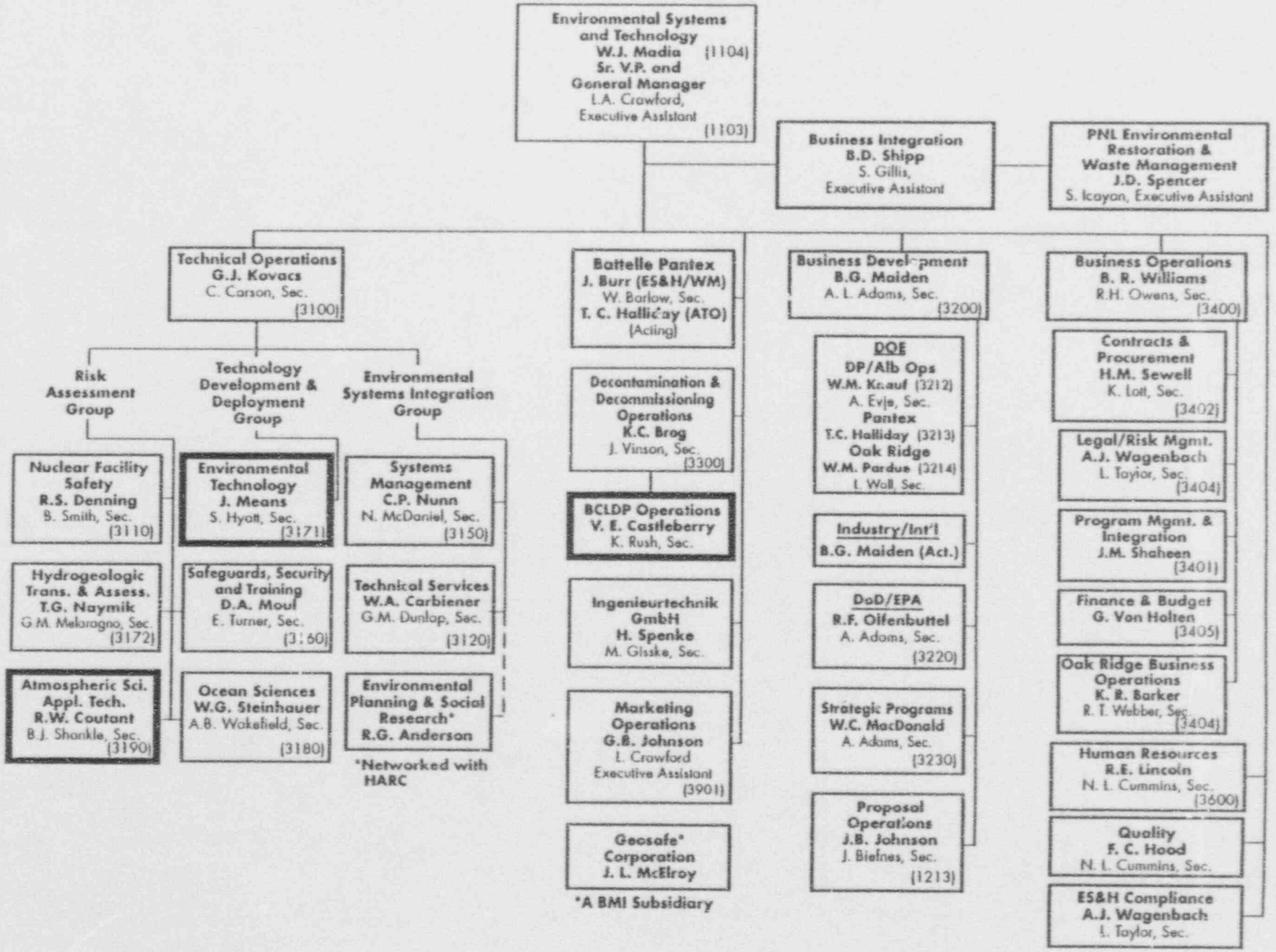


Figure V

Figure VI

Health Division

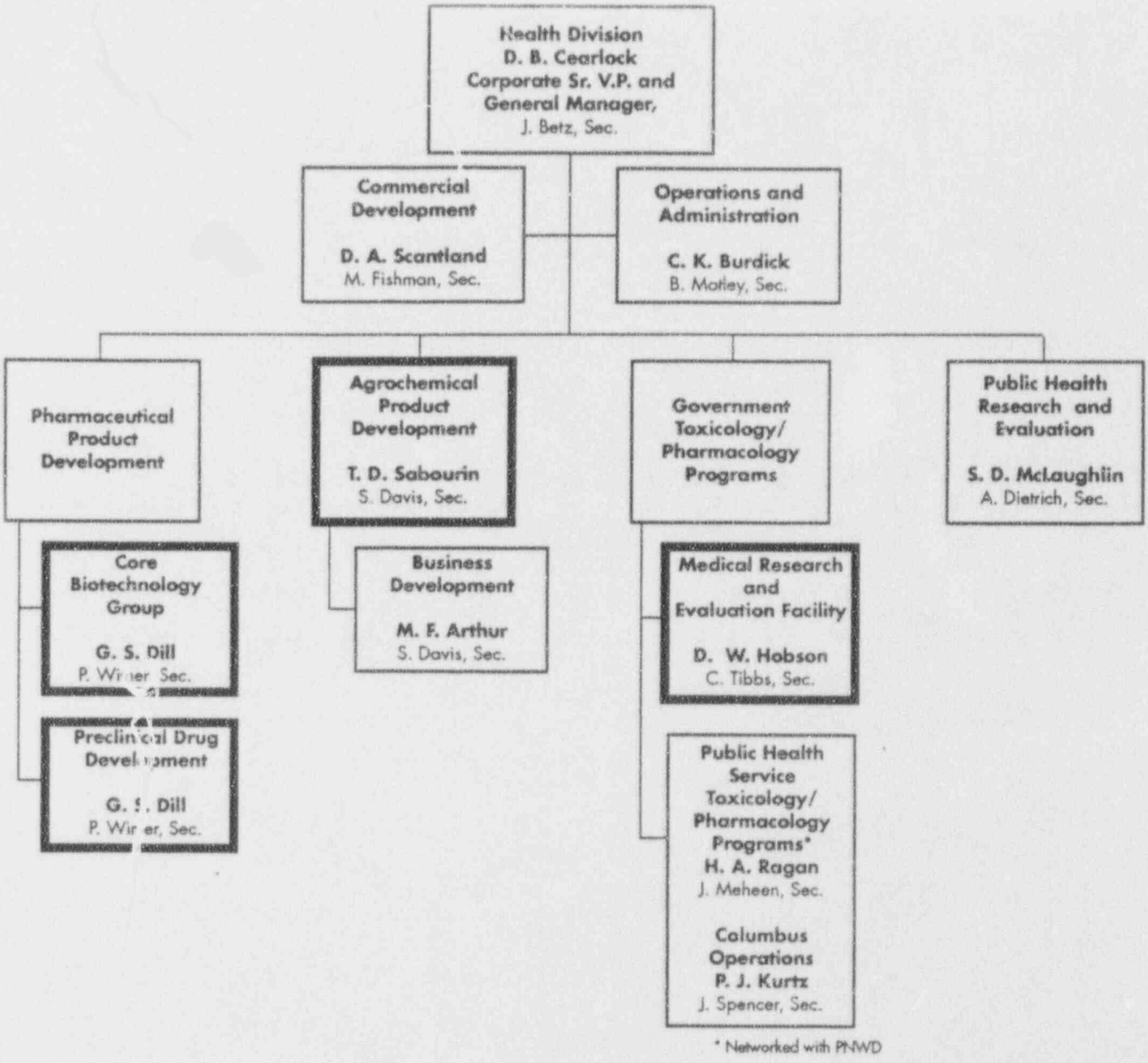
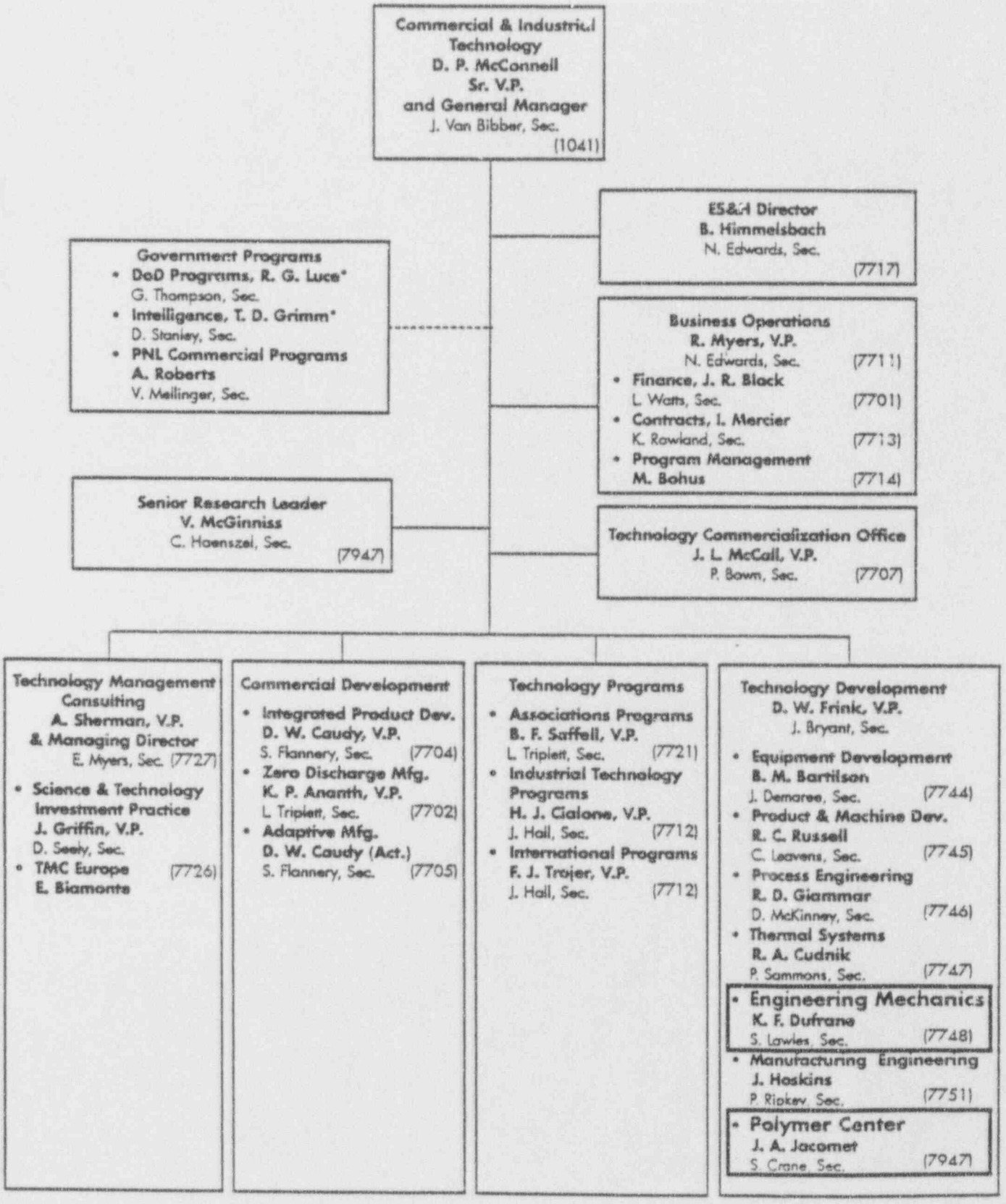


Figure VII

Commercial & Industrial Technology Division



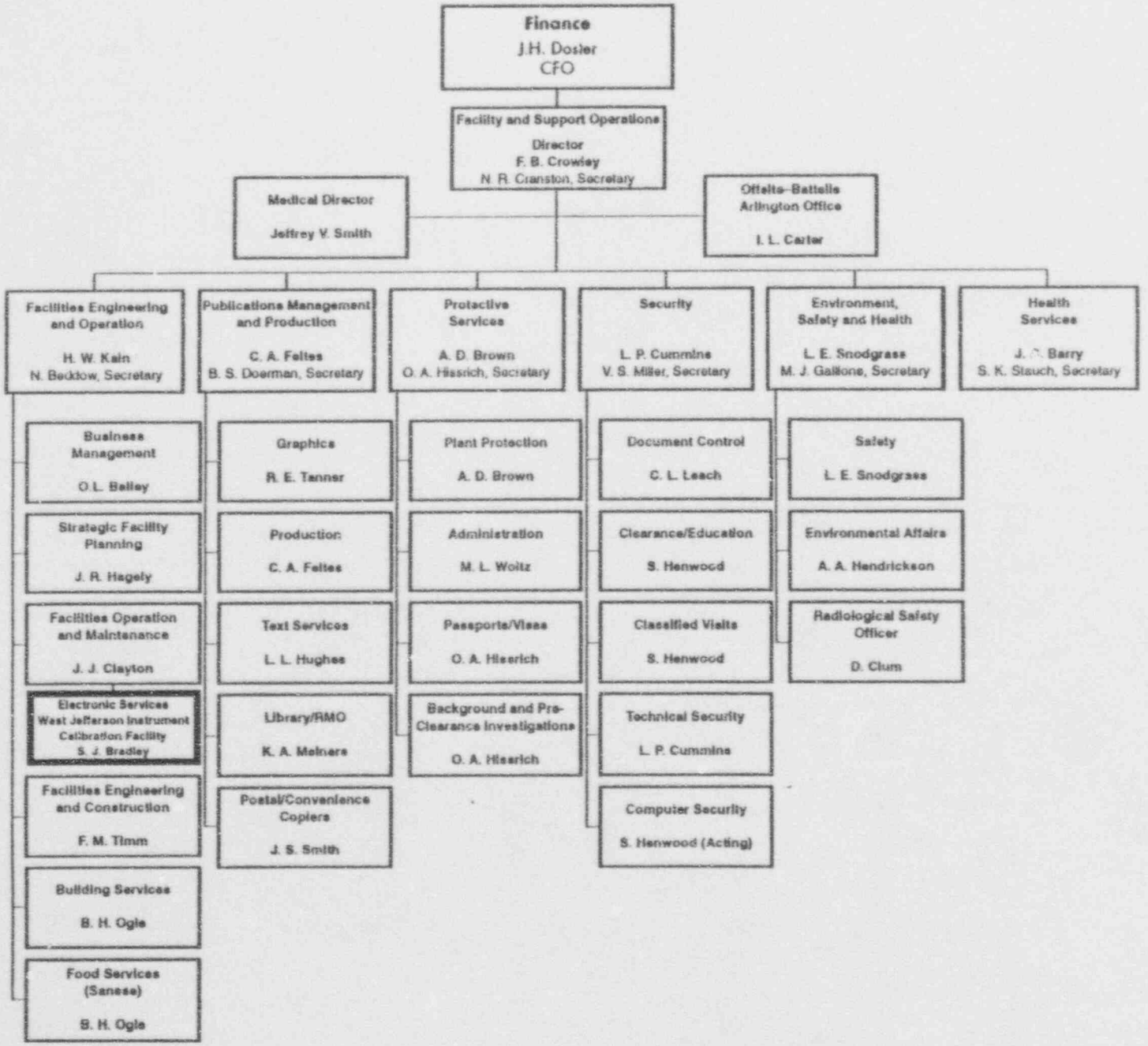

Finance
J.H. Dosier
CFO
Facility and Support Operations
Director
F. B. Crowley
N. R. Cranston, Secretary
Medical Director
Jeffrey V. Smith
Offsite-Battelle
Arlington Office
I. L. Carter
Facilities Engineering and Operation
H. W. Kain
N. Beddow, Secretary
Publications Management and Production
C. A. Feltes
B. S. Doerman, Secretary
Protective Services
A. D. Brown
O. A. Hisrich, Secretary
Security
L. P. Cummins
V. S. Miller, Secretary
Environment, Safety and Health
L. E. Snodgrass
M. J. Gallone, Secretary
Health Services
J. C. Barry
S. K. Stauch, Secretary
Business Management
O.L. Bailey
Strategic Facility Planning
J. R. Hagely
Facilities Operation and Maintenance
J. J. Clayton
Electronic Services
West Jefferson Instrument Calibration Facility
S. J. Bradley
Facilities Engineering and Construction
F. M. Timm
Building Services
B. H. Ogle
Food Services (Sanese)
B. H. Ogle
Graphics
R. E. Tanner
Production
C. A. Feltes
Text Services
L. L. Hughes
Library/RMO
K. A. Meiners
Postal/Convenience Copiers
J. S. Smith
Plant Protection
A. D. Brown
Administration
M. L. Woltz
Passports/Visas
O. A. Hisrich
Background and Pre-Clearance Investigations
O. A. Hisrich
Document Control
C. L. Leach
Clearance/Education
S. Henwood
Classified Visits
S. Henwood
Technical Security
L. P. Cummins
Computer Security
S. Henwood (Acting)
Safety
L. E. Snodgrass
Environmental Affairs
A. A. Hendrickson
Radiological Safety Officer
D. Clum

Figure VIII

Attachment I

Battelle
. . . Putting Technology To Work

Radioactive Material Application

Complete all non-shaded areas.

This form, upon approval, must be posted and/or filed in the section(s) performing operations.

RMA Number _____

RSO Approval _____

Date Approved _____

Distribution _____

1a. Project Number _____ 2a. Expected Start Date _____

1b. Section Number _____ 2b. Length of Study _____

3. For Use in Animals? __ Yes __ No 4. Client _____

5. Project Title _____

6. Principal Investigator _____ (Print Name) _____ (Signature)

Source Custodian _____ (Print Name) _____ (Signature)

Manager _____ (Print Name) _____ (Signature)

7. User(s) _____

_____

_____

_____

_____

8. Location(s):

(a) Where Used _____

(b) Where Stored _____

(c) Hood _____ Safe _____ Refrigerator _____

Other _____

9. Amount of Material Requested Annually From Date of Approval:

(a) Radionuclide _____ (e) Physical Half Life _____

(b) Total Activity _____ (f) Alpha Emitter? _____ Beta Emitter? _____

(c) Physical Form__gas__liquid__solid Gamma/X-ray? _____ Neutron Emitter? _____

(d) Radioactive Form __Unsealed ___Sealed

Assay date _____ S/N _____

*(e) Chemical Form/Compound(s) _____

*Attach copy of MSDS or Equivalent

10. Detailed Technical Abstract of Work to be Performed: _____

_____

11. Is the chemical form of the radionuclide a known carcinogen, mutagen or other toxic agent? _____

(a) Can it be incorporated directly into genetic material? _____

Please complete reverse side

12. Radiological hazards associated with this work may be internal, external or both. Summarize hazards and protective measures to ensure personnel safety and laboratory cleanliness.

13. Describe frequency of radiological monitoring and person(s) responsible for monitoring:

14. Describe emergency actions to be implemented should there be a spill, airborne release or other credible emergency:

15. Estimate waste form, volume and activity. Describe arrangements for waste disposal:

16. Dosimetry Requirement(s):

17. Health Physics Comments:

Battelle
. . . Putting Technology To Work

RADIATION WORK PERMIT

☐ Regular
☐ Extended

RWP Number [ ][ ] [ ][ ] [ ] [ ][ ][ ]
Year KA/JN Bldg RWP No.

SECTION I

Work Instruction # _____ (Attach copy of WI to RWP)

Location

Exposure Category: ☐ ROS ☐ RM ☐ SM ☐ D&D ☐ Demolition ☐ Waste Processing ☐ CHAR

Job Description

Est Start Date Est. End Date

SECTION II

Existing Radiological Conditions:

Radiation Survey No. _____ Contamination Survey No. _____ Airborne Survey No. _____

Existing General Area Radiation Level -- γ β N	Existing General Contamination Level --	Airborne DAC Level(s):	Remarks:
_____ mR/hr/γ _____ mrad/hr/corrected β^- _____ mrem/hr/N	_____ dpm/100 cm^2 β γ _____ dpm/100 cm^2 α	α ____ % P β ____ % P ____ % H_3	
Existing Maximum Radiation Level -- γ β N	**Existing Maximum Contamination Level --**	Hot Particle?	
_____ mR/hr/γ _____ mrad/hr/corrected β^- _____ mrem/hr/N	_____ dpm/100 cm^2 β γ _____ dpm/100 cm^2 α	☐ Yes ☐ No	

SECTION III

Radiological Limits:

Maximum Allowed WB Exposure Rate γN: _____ mR/h or mrem/h
corrected β- _____ mrad/h
Maximum Allowed Contamination Level β-γ: _____ dpm/100 cm^2 α _____ dpm/100 cm^2
Maximum Allowed Airborne Level: _____ % DAC
Maximum Extremity Exposure Rate _____ mr/h

Remarks:

RADIATION WORK PERMIT

(Continued) RWP # _____

SECTION IV

Worker Requirements:

Clothing:
- ☐ Coveralls
- ☐ Lab Coat
- ☐ Cloth Hood
- ☐ Paper Coveralls
- ☐ Plastic Booties
- ☐ Plastic Suit
- ☐ Rubber Shoe Covers
- ☐ Canvas Shoe Covers
- ☐ Cotton Gloves
- ☐ Beta Goggles/Face Shield
- ☐ Rubber Gloves
- ☐ Extra _____
- ☐ Other Clothing _____

Dosimetry:
- ☐ Standard
- ☐ Elbows
- ☐ Hot Cell Entry
- ☐ Gonad Pack
- ☐ Extremity
- ☐ Head Pack
- ☐ Varying Field
- ☐ Special
- ☐ Knees
- ☐ Upper Field
- ☐ Ground Field
- ☐ 200/500 mR Dosimeter
- ☐ 1000/5000 mR Dosimeter
- ☐ Alarming Dosimeter
- ☐ _____

Instructions:
- ☐ Contact HP for Line Breaks
- ☐ Contact HP Prior to Work in New Areas
- ☐ Protect Cuts
- ☐ Site Special Instructions
- ☐ Have Equipment Monitored at End of Job
- ☐ Modesty Required
- ☐ Clean Up Work Area During and After Job
- ☐ Frisk Upon Exiting a Contaminated Area
- ☐ Have Prescribed HP Coverage or Stop Work
- ☐ Pre-Job Briefing
- ☐ Post-Job Briefing

Respiratory:
- ☐ FFNP
- ☐ FFAL
- ☐ Bubble Hood
- ☐ SCBA
- ☐ _____

Staytime: ___ hrs

Special Instructions: Contact H.P. at Ext. 4-4889 for KA or 4-3802 for WJ. The dressout requirements are the minimum required; additional clothing is not allowed without HP approval.

Attach DDO-103 for Continuation

SECTION V

Health Physics Requirements:

1. Job Coverage ☐ Continuous ☐ Intermittent ☐ Start ☐ End of Job

2. Air Sampling ☐ General Area ☐ Breathing Zone ☐ Lapel ☐ Particulate ☐ Charcoal ☐ AgZ ☐ Tritium/C-14

3. Exposure Rate Surveys ☐ Start of Job ☐ Continuous Monitoring ☐ Intermittent Monitoring ☐ End of Job ☐ Area Monitor ☐ Check AD Every _____ mins.

☐ Check for Hot Particles Every _____ mins. on workers _____ mins. in work area

4. Is the ALARA Consideration Complete and Attached? ☐ Yes ☐ No Why? _____

5. Contamination Surveys: _____

6. Other: _____

Attach DDO-103 for Continuation

H	Approvals/Reviews		I	Termination
	Planner Generating RWP	Date / Time /		Date/Time
	Building Manager	Date / Time /		Health Physics Representative
	Industrial Hygiene Approval	Date / Time /		Reason ☐ Job Completed ☐ RWP Revision
	HP Supervisor Approval	Date / Time /		HPS Review:
	RFO Manager Approval	Date / Time /		