PURDUE
UNIVERSITY

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

March 15, 2010

Ms. Mary T. Adams
Fuel Manufacturing Branch
Mail Stop E-2-C40M
11555 Rockville Pike
Rockville, MD 20852

Dear Ms. Adams:

Enclosed is a resubmission of the license renewal for SNM-142 in its' entirety. This was done to reflect the changes in possession limits for natural uranium and 1.3% enriched uranium that will be shipped for disposal in the very near future.

If you should have any questions regarding this information please contact me at 765-494-2350. Thanks for your attention to this matter.

Sincerely,

James F. Schweitzer
Radiation Safety Officer

NMSS01
NMSS

550 Stadium Mall Drive ■ West Lafayette, IN 47907-2051 ■ (765) 494-6371 ■ Fax: (765) 494-7403

5.0 Radioactive Material to be Possessed

Element and Mass Number	Chemical and/or Physical Form	Maximum Possession
Text Withheld Under 10 CFR 2.390		

The following material will not be used for experimental or research purposes, it will be **for storage only:**

5.0 (a)(1) SPERT fuel rods, enriched to less than 4.8%

6.0 Purpose for Which Licensed Material Will Be Used

a. The proposed use of U-235 enriched solid helices and discs is to measure the effects of rare earth additions on the thermal properties of UO_2 and to measure the effects of elevated temperatures on the mechanical properties of UO_2. Typical experimental procedures involve heating solid discs or helices of various U-235 enrichment (3-20%) to a maximum temperature of 500°C for differential thermal analysis and 1600°C for thermal diffraction measurements. Helices are typically heated in a vacuum furnace for measurement of mechanical properties. **The above procedures are not actively used at this time and it is expected that these will not be implemented in the future.** Other various samples of both enriched and natural uranium may be obtained for non-destructive testing, chemical and thermal analysis, and other analytical and developmental techniques.

b. The encapsulated Pu-Be neutron sources are employed in activation analysis studies, for instrument calibration, for neutron studies in a subcritical exponential pile, and for other research approved by the Radiation Safety Committee. (Note: The natural uranium subcritical pile is separately licensed under Source Material License SUD-296)

c. Uranium-235 in the form of SPERT fuel rods enriched not to exceed 4.8 weight percent, fuel rods enriched not to exceed 1.3 weight percent, natural UO_2 pellets clad in aluminum, and californium in doubly encapsulated sources were possessed to be used in the operation of a subcritical Fast Breeder Blanket Facility (FBBF). The FBBF was a small subcritical facility in which blankets of fast reactors were simulated in a realistic geometrical configuration. The FBBF consisted of a central region composed of 4.8% enriched fuel rods to provide the surrounding blanket mockup with a neutron spectrum typical of that found in the core blanket interface of a large LMFBR. Natural uranium fuel rods were used in the blanket mockup. The 1.3% enriched fuel rods are stored in Duncan Annex as will be described later. The FBBF was subcritical with K_{eff} of less than 0.43. The FBBF was driven by Cf spontaneous fission neutron sources distributed along its centerline. Up to a maximum of 0.002g of Cf-252 possession is requested in order that the original sources may remain in place until the facility is decommissioned.

   The 4.8% enriched fuel remaining in Physics B28 will be moved to EE B77A to consolidate enriched uranium to one location and reduce the security requirements for the Physics location. The converters with 4.8% enriched uranium all are in a subcritical configuration and will remain so (unopened) until decommissioning efforts are initiated. All enriched uranium rods will be stored in a subcritical geometry as will be described later. Natural uranium rods and 1.3 % rods may be used for non-destructive testing and as sources for detector development and testing.

Procedures used in teaching, research and decommissioning activities of the FBBF will be reviewed for safety by the Radiation Safety Committee and the Radiation Safety Officer and/or his staff. All decommissioning activities with licensed material will be conducted in accordance with written procedures and will not commence until approval of decommissioning activities is granted by the Nuclear Regulatory Commission. Any active procedures will be approved by the Radiation Safety Committee and will be updated at least every two years. At this time the only active procedures involve the use of PuBe sources for teaching purposes related to the subcritical pile licensed under Source Material License SUD-296. The Radiation Safety Committee is responsible for:

1. Reviewing plans, specifications, and procedures for activities of the FBBF and taking appropriate action.

2. Reviewing any significant proposed changes in design, activities, or decommissioning of the FBBF. Committee approval or Radiation Safety Officer approval is required in advance of initiating such changes.

3. Approving activities associated with the FBBF.

4. Authorizing personnel to work in the facility.

5. Overseeing all radiation safety aspects of the FBBF, including routine surveys, leak tests, personnel monitoring, instrument calibration, emergency procedures, and inventory.

d. U-233, Np-237, Pu-239, and Cm-244 (Sections e-h of Item 5) will be used as calibration sources and fission foils.

7.0 Individuals Responsible for Radiation Safety Program and Their Training and Experience

7.1 Senior Administration

The governing body of the University is the Board of Trustees, which selects the president of the University. The president, France A. Cordova, as the chief executive officer, is responsible to the board for the internal administration of the University. The executive vice-president and treasurer, Al Diaz, serves as the chief business and financial officer for the University with responsibility for all business offices, the physical plant, residence halls, facilities development, investments, and trusts. He acts for the president with administrative authority for managing, developing, and planning in all of these areas. The executive vice-president and treasurer serves as certifying official for NRC license documents. The vice-president for physical facilities, Robert E. McMains, assists and acts for the executive vice-president and treasurer with administrative responsibility for operation of the Physical Facilities. Charts of the organization are in Attachment 7-1.

7.2 Radiological and Environmental Management (REM)

The Director of REM and the Radiation Safety Officer is James F. Schweitzer, Ph.D., CHP. This department is responsible for the implementation of general safety, industrial hygiene, chemical safety and management, environmental health, and radiological safety. This comprehensive program allows interaction and coordination of all facets of environmental and laboratory safety.

7.3 Radiation Safety Committee (RSC)

The RSC is empowered by Executive Memorandum B-14 dated May 1, 2001 (Attachment 7-2) to act as the body responsible for all University programs involving radioactivity or radiation producing devices. The RSC meets at least quarterly and an attendance of at least 50% is considered a quorum. Membership of the committee is diversified and representation from different areas of use (e.g. life sciences, nuclear engineering and/or veterinary medicine) is maintained to ensure appropriate review of research uses of radioactive material.

All new investigators (authorized users) are approved by the RSC at the quarterly meetings. All major changes in existing authorizations are also approved at these meetings. The Radiation Safety Officer (RSO) is authorized to give interim approval to investigators whose use is similar to uses that have been approved in the past by the full committee. If in the judgement of the RSO, the use is substantially different from past uses or involves an interpretation of guidelines or regulations then the full committee must approve the authorization.

The Senior Director of Environmental Health and Public Safety (management representative), Radiation Safety Officer (RSO), and a health physicist (secretary) serve as ex officio committee members. The current RSC is listed in Attachment 7-3. The membership of the committee may change due various reasons however membership will be limited to individuals having knowledge of and experience with radioactive materials.

In addition to those duties described by Executive Memorandum B-14 the RSC performs these duties:

Review and renew authorized user permits at two-year intervals.

Review annual audit findings and make recommendations to radiation safety staff for appropriate action.

Review regulatory actions such as license amendment submissions to the NRC and results of periodic NRC inspections.

Establish and approve minutes of all proceedings and actions taken by the committee.

7.4 Radiation Safety Officer (RSO)

The current RSO is James F. Schweitzer, Ph.D. Dr. Schweitzer received his M.S. degree in Health Physics (1981) and Ph.D. in Environmental Toxicology (1985) from Purdue University. He was employed at the Illinois Department of Nuclear Safety from 1986-87 where he worked in the environmental monitoring and radon section. He was employed as the Radiation Safety Officer at Purdue in 1987. His experience includes the use of millicurie amounts of unsealed byproduct and source material and multi-curie amounts of sealed sources for teaching and research, calibration, and in self-shielded irradiators.

The primary duties of the RSO include but are not limited to the following:

Administration of the Radiation Safety Staff (RSS) with the overall responsibility of managing the radiation safety program.

Ensuring compliance of the radiation safety program with state and federal regulations and NRC license conditions.

Providing training and recommendations to individuals that use radioactive materials.

Act as the agent of the Radiation Safety Committee to ensure that use of radioactive material is consistent with recommendations and requirements of the committee.

Serve as representative of the University to regulatory agencies to act in licensing matters and providing corrective action when deficiencies are identified.

7.5 Radiation Safety Staff

Radiation Safety Officer. The duties of the RSO are described above. The RSO should meet the requirements as described in the Draft Regulatory Guide (April, 1982), "Qualifications for the Radiation Safety Officer in a Large-Scale, Non-Fuel Cycle Radionuclide Program"

Health Physicists (2). The Health Physicists are required to have a B.S. degree in Health Physics or a related area. If the degree is in a related area, experience in a medical or university health physics program is highly desirable.

Environmental Technician (4). The technicians are required to have a high school diploma but no other relevant experience. These individuals work under the supervision of the RSO or a health physicist.

Student Assistants. Work-study students and undergraduate interns are hired to perform basic health physics tasks or other tasks under the supervision of various radiation safety staff. No previous experience is required.

7.6 Experimental and Teaching Use of Licensed Material

SNM for which possession is requested in this application is under the direct control of individuals in the Nuclear Engineering Department who have been authorized by the Radiation Safety Committee. Direct control over the activities of the FBBF and the storage and/or use of SNM, source materials and byproduct material will be under the direction of the Department of Nuclear Engineering.

The Head of the Department of Nuclear Engineering will appoint the Laboratory Director and Assistant Laboratory Directors (if appointed). Individuals appointed to these positions will have had formal training in their field and or sufficient practical experience to be considered qualified to assume the duties associated with the appointment. The safety and security responsibilities of the Laboratory Director and the Assistant include:

1. Ensuring that the uranium fuel is stored and maintained in compliance with license conditions.

2. Preparing procedures for Radiation Safety Committee approval.

3. Assuring that personnel working with SNM have been approved by Radiological and Environmental Management.

4. Maintaining Physical inventory and associated records.

In matters regarding radiation safety, the line of authority for reporting purposes is directly to the Radiation Safety Committee through the Radiation Safety Officer. The Radiation Safety Committee is authorized to act on radiological safety concerns without further administrative approval. The individuals currently responsible for use, inventory, and radiation safety at the facilities are Jere Jenkins, Laboratory Director and Edward Merritt, Assistant Laboratory Director. These personnel may change from time to time as appointed by the Head of the Nuclear Engineering Department and approved by the Radiation Safety Committee.

8.0 Training for Individuals Working In or Frequenting a Restricted Area

The extent of training for individuals in a restricted area is dependent on factors such as responsibility of the individual, duties in the area, and frequency in the area. Personnel are divided into two main categories: radiation workers and support staff.

8.1 Training for Support Staff

The areas where licensed material is stored or used are not accessible to support staff unless accompanied by an individual who has been given authorized unescorted access. The individuals who provide escort are limited to Nuclear Engineering or REM health physics staff. Since there is no likelihood that these individuals could exceed 100 millirem EDE (limit to members of the public) no formal training program is in place. The support staff will

performing. Examples of individuals that require escorting are maintenance personnel (plumbers and electricians) and service staff.

8.2 Training for Radiation Workers

All radiation workers receive instruction in accordance with 10 CFR 19.12 prior to beginning work with licensed material. This instruction is web-based training followed by an exam covering the training information. Each user regardless of prior experience is required to attend this orientation and training session and review the Radiation Safety Manual (Attachment 8-1). If the individual uses material other than sealed sources a hands-on session on survey and waste procedures and contamination control is provided by a health physicist or radiation safety technician. Information covered by the training includes:

Purpose of Radiological and Environmental Management

Principles of ALARA

Special Notices (e.g. Results from latest NRC inspection)

Instruction Regarding Prenatal Exposure (Regulatory Guide 8.13)

Discussion of 10 CFR Parts 19 and 20

Personnel Dosimetry and Exposure Limits

Hazards Associated with Commonly Used Isotopes

Decontamination and Accident Procedures

Waste Management Procedures

Marking and Labeling of Facilities and Equipment

Demonstration of Survey Techniques

8.3 Principal Investigators

Principal investigators (authorized users) are those to which an authorized use of radioactive material is granted. The principal investigator (PI) may have radiation workers such as graduate students, postdocs, technicians, or other Purdue staff or students that work under his authorization. The PI must be a permanent Purdue staff member with a college degree at the bachelor level or have equivalent training and experience in the physical or biological sciences or in engineering and attend the radiation safety training. In addition, the PI must have at least 40 hours of training and experience in the safe handling of radioactive materials, and in the characteristics of ionizing radiation, units of radiation dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of byproduct material to be used.

Principal investigators not meeting these criteria may be asked to work under the authorization of an existing user until he has received the requisite training and experience. The RSC reviews each PI to evaluate the training and experience and the amounts and types of licensed material requested. Approval is given when the RSC is satisfied that the PI can work safely with the given type and amounts of licensed material.

8.4 Radiation Workers

Radiation workers (users) are authorized as full users when their training and experience is sufficient to work with the quantities and types of radioactive material that the principal investigator is licensed to use. Some users may have little or no experience working with licensed material. In that case, the individual is authorized as a restricted user who may only use smaller quantities until he receives additional training and experience. Once the PI has certified that the individual has received the training and experience the user may become fully authorized to use licensed material in those procedures for which the laboratory is authorized to perform.

8.5 Continuing Education (Refresher Training)

The continuing education program will be conducted on at least an annual basis. Since there is limited use of licensed material the hazards that each individual are exposed to are very minimal. These programs are provided by REM for all users of byproduct material. This refresher training covers items such as survey techniques, NRC regulations, and NRC items of emphasis.

8.6 Authorization Procedures

After attendance at the orientation and safety training the principal investigator must submit the appropriate documentation for authorization. A Form A-1 describes the isotopes and amounts, proposed uses, procedures, associated hazards, and techniques to prevent contamination and keep exposures ALARA. The Form A-1S provides a description of the facility and the amount of licensed material to be used in each area. The Form SM-1 provides a

description of the survey meter (if required). The Form A-4 is required for each authorized user that intends to work under the supervision of a particular PI. Examples of these forms are found in the Radiation Safety Manual.

9.0 Facilities and Equipment

9.1 Special Nuclear Material

SNM will be used and/or stored in two locations on the Purdue University campus. The buildings are the Electrical Engineering Building (EE or Duncan Annex) and the Physics Building. Their location is marked on the map of the Purdue University campus. (Attachment 9-1) In addition, other locations may be used from time to time when approved by the Radiation Safety Committee.

Duncan Annex Storage Facility

EE Room B84

SNM are stored in this room of the Duncan Annex, which is a part of the Electrical Engineering Building. The storage room is approximately 5.6 m. by 9.35 m by 7.0 m high, as shown in Attachment 9-2 and 9-3. The floor level is about 2.74 m below the outside ground level. The building is constructed of steel frame with concrete and brick and no window openings.

Enriched UO_2 fuel (1.3%) is stored in Room B84. The 1.34 m long fuel rods (active fuel length 1.22 m) are stored in a steel cabinet. The cabinet is designed to hold the rods vertically in a slab geometry and are fastened to the wall (Attachment 9-4). The limit for controlling the k_{eff} for each array is the slab thickness. Using Figure 3 from ANSI/ANS-8.1-2007, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors", the maximum safe slab thickness for 1.3% uranium oxide is approximately 28 cm. The actual thickness of the storage geometries in these cabinets is 14 cm.

Room B84 also contains a natural uranium metal graphite subcritical assembly with a k_{eff} of 0.642. Any extra fuel from the graphite assembly is stored in a cabinet on the wall behind the subcritical facility and at least 4.5 m from the nearest cabinet containing the 1.3% fuel.

EE Room B77A

This storage room is approximately 2.75 m by 2.45 m and 2.7 m in height (Attachment 9-5). Enriched UO_2 fuel (4.8%) with an active fuel length of 91cm is stored in metal racks designed to store the rods vertically in a slab geometry. The racks are fastened to the opposite walls of the fuel storage room and are separated by a distance of 1.98 m. Again, using Figure 3 from ANSI/ANS-8.1-2007, the maximum safe slab thickness for 4.8% uranium oxide is approximately 10 cm. The actual thickness of these arrays is less than 9 cm.

uranium oxide is approximately 10 cm. The actual thickness of these arrays is less than 9 cm.

Sealed converters containing 4.8% uranium currently stored in Physics B28 will be moved to this location or to EE B84. These converters are sealed and in a subcritical geometry in any conceivable environment, including flooded storage.

Physics Building Fast Breeder Blanket Facility Laboratory (Physics B28)

This laboratory is operated as part of the School of Nuclear Engineering. The laboratory is located in rooms in the Physics Building on the Purdue Campus (See Attachment 9-1). The building is constructed of steel frame with concrete and brick. The floor plan of the laboratory is shown in Attachment 9-6. The dimensions of room B28 are approximately 15.5 m. by 15.2 m by 6.1 m high. The floor level is about 2.4 m below the outside ground level and is about 76 cm above the floor level of the newer portion of the Physics Building. Sealed converters (2) (Attachment 9-7) are also stored in the cage area and will be moved to one of the three secured areas in EE basement (B-77A, B-84, or B70) once the license is renewed.

The Fast Breeder Blanket Facility was located in room B28C as shown previously. One sealed converter with 4.8% enriched rods is currently stored in this area. The facility is set on a concrete base approximately 61 cm below the floor level of room B28 (See Attachment 9-8). The center of the facility is approximately 10 m from the center of the nearest steel storage cabinet. Room B28C is a concrete housing constructed within room B28 to enclose the FBBF. The walls and roof of room B28C have been designed so that radiation levels outside of room B28C will be acceptably low.

Physics B28 is provided with supply ventilation from the main supply plenum from the physics building basement hallway. This air is a mixture of outside air and recirculated air from other parts of the building. Approximately 500-600 cfm of air is exhausted from B28C by a fan located in the attic and the room is maintained at a net negative pressure of 0.05 in of water. The flow of air from B28 to B28C is primarily around the door frame when the door is closed.

9.2 Criticality Alarms

The Remote Area Monitors are installed in the FBBF to serve as a radiation and criticality accident alarm system to meet the requirements of 10 CFR 70.24 and ANSI/ANS 8.3-2003, "Criticality Accident Alarm System." Once the enriched uranium is relocated to EE B77A the criticality alarms will no longer be a requirement for this area.

9.3 Request for Exemption to 10 CFR 70.24.

We request an exemption to 10 CFR 70.24(a)(l) requiring an area monitoring system for the storage facilities for SNM located in Duncan Annex. The exemption is requested on the basis

that the facilities are for storage only of the fuel and helices. Numerous survey meters are available in the area at all times.

9.4 Instrumentation

Purdue University has extensive instrumentation for the determination of contamination, exposure rates, and radioactivity in solid and liquid samples. Laboratories associated with the use of radioactive materials must have access to radiation monitoring equipment for the purpose of measuring these parameters and the equipment must be appropriate for the type of radiation(s) involved. Survey instruments are required to be calibrated at least annually; all calibration reports are on file with the Radiation Safety Office.

Purdue University commits to adopt the "Instrument Specification and Model Survey Instrument and Air Sampler Calibration Program" as presented in NUREG-1556 Vol. 11, Appendix O.

10.0 Radiation Safety Program

10.1 Personnel Monitoring Devices

Film badges or other devices such as TLDs are generally used as personnel monitors of radiation exposure. Any person working with SNM is required to wear personnel monitoring devices whenever entering a restricted radioisotope area under conditions where the individual is likely to receive a dose in excess of 10 percent of the limits specified in 10 CFR 20.1502. In addition, pocket dosimeters may be worn by personnel in addition to film badges in cases where exposures would reasonably be anticipated. Pocket dosimeters may be utilized in lieu of film badges for individuals entering restricted areas on an infrequent or temporary basis.

The dosimeters are read monthly or bimonthly using a NVLAP accredited supplier. An annual review, not to exceed fourteen months, is made of personnel exposures. In cases where individual monthly doses exceed 100 millirem, the Radiation Safety Office notifies the individual (or his/her supervisor) of the exposure as a means of alerting the individual to the occurrence of the dose.

10.2 Bioassays

No formal bioassay program has been established for individuals working with SNM. At this time there is no manipulation of unsealed material that could result uptake of any licensed material. Exposure potential will be evaluated if conditions change, to ensure individuals that may receive in excess of 10 percent of the ALI are monitored.

Bioassay, however, may be required of certain individuals who will work with SNM during decommissioning. The Radiation Safety Officer or his staff will establish written procedures

for such bioassay evaluation which could include analysis of urine or other excreta, depending on the nuclide, its chemical and physical form, and the mode of intake. The Radiation Safety Officer will be authorized to require the submission of other excreta (such as fecal samples, nose wipes, or breath samples) in addition to or in lieu of urine samples. Appropriate engineering controls, PPE, and air sampling will be employed to keep exposures ALARA during the decommissioning process.

10.3 Surveys and Monitoring

Surface contamination surveys are conducted at the FBBF facility every month, not to exceed six weeks, to determine levels of removable contamination. Smears are taken of 100 cm^2 areas. Acceptable surface contamination levels are shown in Attachment 10-1. The amount of removable radioactive material per 100 cm^2 of surface area is 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 are reduced proportionally and the entire surface is wiped.

The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at the surface, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

When observed contamination levels reach the above levels, decontamination must take place. From an operational point of view, every effort is made to keep contamination levels below those set forth in the table above. Although not an official action level, in practice, any time removable contamination levels above 10% of the table value is reached, decontamination is accomplished.

No maximum time allowed before decontamination is actually started has been established. Contamination problems are assessed on an individual incident basis and after review of the situation a decontamination plan is decided upon. After the tabled levels are exceeded, the area is restricted except for decontamination activities.

10.4 Personnel Surveys

Protective clothing and/or devices will be used for all manipulations with unsealed sources where the possibility of contamination exists. In particular, suitable gloves will be worn whenever hand contamination is probable. Surgical glove techniques are used for putting on and removing gloves in order to avoid contaminating the inside surfaces. Thorough monitoring of hands, feet and clothing should be performed whenever the potential for personnel

contamination exists. If personal clothing or skin contamination levels are above established action levels, persons shall not exit an area without decontamination or approval of the Radiation Safety Officer or his designated alternate.

Laboratory clothing or protective garments (such as lab coats) used in radioisotope laboratories are monitored routinely during the course of the work and when work with the radioactive materials is completed. Such garments will not be released for washing or cleaning until they have been monitored by the user and found to be free of contamination. Contaminated garments will not be worn elsewhere, (outside the radioisotope laboratory or in "clean" areas.) Articles, which show contamination, will be left in the work area, or other areas designated for this purpose. Such clothing will be marked by the user with his name, date, and the nature and degree of contamination and held for storage until the activity has decayed to background level; or decontaminated; or disposed of as radioactive waste.

In the case of skin contamination, decontamination by soap and water washing will be initiated as soon as is practicable. In stubborn cases, the use of chelating agents, mild oxidants, solvents, and isotope dilution solutions will be used to reduce skin contamination levels to background levels.

10.5 Leak Tests

a. Plutonium source are tested for leakage at intervals not to exceed six (6) months. In the absence of a certificate from a transfer indicating that a test has been made within six (6) months prior to the transfer. Sealed sources are not be put into use until tested.

b. The test will be capable of detecting the presence of 0.005 microcuries of alpha contamination on the test sample. The test sample will be taken from the source or from appropriate accessible surfaces of the device in which the sealed source is permanently or semipermanently mounted or stored. Records of leak test results will be kept in units of microcuries and maintained for inspection by the Commission.

c. If the test reveals the presence of 0.005 microcurie or more of removable alpha contamination, the licensee will immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired by a person appropriately licensed to make such repairs or to be disposed of in accordance with the Commission regulations. Within five (5) days after determining that any source has leaked, the licensee will file a report with the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, describing the source, the test results, the extent of contamination, the apparent or suspected cause of source failure, and the corrective action taken. A copy of the report shall be sent to the Director of the nearest NRC Inspection and Enforcement Office listed in Appendix D of Title 10, Code of Federal Regulations, Part 20.

d. The periodic leak tests do not apply to sealed sources that are stored and not being used. The sources excepted from this test will be tested for leakage prior to any use or transfer to

another person unless they have been leak tested within six (6) months prior to the date of use or transfer.

e. Leak tests of the Cf-252 sealed source will be performed only at times when it is removed from the FBBF assembly for purposes of source transfer, replacement, or similar activities. When the Cf-252 source is leak tested, conditions b and c, above, will apply.

10.6 Procedures for Opening Radioactive Materials Packages

All packages received at Purdue University will be monitored in accordance with 10 CFR 20.1906 for external contamination and dose rate. General procedures for opening packages are as follows:

1. Prior to opening packages put on appropriate personnel protection such as gloves.

2. Note any specific instructions by the supplier with regard to special precautions for opening the package.

3. Smear the outside of the package to verify that contamination limits are not in excess of that specified by 10 CFR 71.87(i). Notify RSO if these limits are exceeded.

4. Use an ion chamber or GM survey meter to verify that external exposure rates are within those specified by 10 CFR 71.47. Notify RSO if these limits are exceeded.

5. Packages, which have obvious damage to the outer container, should have the integrity of the inner containers verified. If there is a question as to the integrity of any inner container it should be smeared to verify that the contents have not leaked out.

6. Personnel opening packages should use the principles of ALARA (time, distance, and shielding) to maintain exposures as low possible.

7. Any records such as package logs, calibration data, and inventory must be recorded if required.

8. If material ordered is received in a satisfactory condition then the user should be notified for pickup.

10.7 Procedures for Maintaining Inventory and Accountability

All radioactive material is accounted for in REM by using a computer database program. As previously mentioned, each individual order is checked versus the possession limit for each particular PI inventory. Once the material is received the amount is added to the inventory of

the PI possessing the material. The PI is also responsible for keeping records within the laboratory for receipt and disposal.

As waste material is picked up from each laboratory this amount is subtracted from the running total that is maintained by the computer program. At any given time, it is then possible to retrieve the amount that a particular PI has in inventory (the program also decays activity). Each PI verifies his inventory on an annual basis to correct for variations in estimates of material that has been assigned to waste or has decayed.

A printout of the entire inventory is generated on a quarterly basis so the RSO or his designate can verify that license quantities have not been exceeded. The amounts on the inventory are compared with the license amounts and plans can be made to accommodate future research needs without undue delay.

Yearly totals are also generated for material that has been disposed of via the sanitary sewer and through incineration. Since the MPC is never exceeded on a single day it is not necessary to generate a running total to ensure that the yearly MPC is not exceeded. However the database is in the process of being modified so that information can be retrieved in a report form that can be presented to the RSC or management representatives.

10.7 General Rules for the Safe Use of Radioactive Material

Laboratories are strongly encouraged to utilize good laboratory practices and maintain the facility with good housekeeping in mind. General rules apply to all individuals working with radioactive material unless specific exemptions have been granted by the RSC or RSO or use of the general rules are incompatible with other safety provisions or procedures.

1. All areas where radioactive materials are used or stored will be posted in accordance with 10 CFR 19.11 and 10 CFR 20.1902.

2. Eating, drinking, food preparation, food storage, and smoking is not permitted in laboratories where significant amounts of radioactive materials are used or stored.

3. The use of food containers for handling or storing radioactive materials is not permitted. Any other containers used must be clearly marked as containing radioactive material.

4. The pipetting of radioactive solutions by mouth is strictly prohibited.

5. A trial run without radioactive material should be conducted for all new procedures prior to the use of radioactive material.

6. Any work performed with volatile radioactive material (such as sodium iodide) or operations that have the potential for personnel exposure or contamination must be performed in an appropriate hood or glove box.

7. Protective equipment such as gloves and lab coats must be used for all manipulations of unsealed sources. In addition, eye protection must be worn when working with materials that may be hazardous to the eyes. Eye protection is required when handling greater than 10 millicuries of high-energy beta emitters such as P-32.

8. Protective equipment must not be worn outside the laboratory unless it has been monitored and found to be free of contamination.

9. Work surfaces that may be subject to contamination should be covered with absorbent paper that is changed on a regular basis. Any work with large volumes of material or a process with a high spill probability should be done in a spill tray.

10. A radiation survey should be performed by the radionuclide user at appropriate intervals. The survey may be conducted with a survey instrument or wipes depending on the isotope used. Items found to be contaminated should be placed in a suitable area, decontaminated, or disposed as radioactive waste.

11. Contamination must not be allowed to remain in any area for an extended period of time. If contamination is found outside the immediate use area, REM should be notified immediately.

12. Radioactive material use, survey, and inventory records should be maintained at all times by the principal investigator.

10.8 Emergency Procedures

Emergency procedures are designed primarily to protect personnel from radiation and other physical hazards in the workplace. Secondarily, these procedures protect facilities and confine any contamination to the immediate area. All personnel are instructed in emergency procedures during initial training and are given copies of emergency procedures which appear in the Purdue Radiation Safety Manual. Radiation workers are encouraged to refer to this manual on a regular basis. Numbers for emergency response are posted on all laboratories that utilize radioactive material. The University has also has developed an emergency procedures manual that includes the responses to various types of emergencies including tornados, bomb threat, etc. A copy of this manual is not included but can be found at http://www.purdue.edu/fire/safety_handbook.pdf

One member of the radiation safety staff is on call (wears a pager) at all times to respond to emergencies involving radioactive material. Other members of the staff are listed with the police department, so these individuals may be reached if further assistance as needed. The

Purdue Fire Department is also trained in hazardous material response that includes radioactive material. Mutual aid agreements exist for additional assistance from other local municipalities.

10.9 REM Laboratory Surveys and Monitoring

Surveys and monitoring are performed by REM staff on a regular basis according to the hazard classification of the particular laboratory. Frequencies for Class A labs are weekly, Class B labs are monthly, Class C labs are quarterly, and Class D labs are annually. The audits of each lab check the following items:

1. Results of last survey to identify that any problem areas have been corrected.
2. Amounts and isotopes used in the laboratory.
3. Direct radiation survey throughout the laboratory to identify any contamination areas or areas where posting is required by 10 CFR 20.1902.
4. Location and verification of operation of laboratory survey instrument (if required).
5. Proper waste disposal practices.
6. Security of radioactive materials if lab is not attended.
7. Proper labeling of equipment and radioactive storage areas.
8. Utilization of proper protective equipment such as lab coat and gloves.
9. Observance of eating, drinking, and smoking prohibitions.
10. Personnel dosimetry is worn if necessary.
11. Wipe tests of selected areas to determine that contamination has not been inadvertently missed by laboratory personnel.
12. Interviews with laboratory personnel will be conducted on a periodic basis to verify that all individuals have been authorized by REM and appropriately trained by the PI. Training or information regarding an aspect of radiation safety is usually covered at this time.
13. Inspection of survey records maintained by the laboratory (if required).

10.10 ALARA Program

Purdue University is committed to providing a working place relatively free of recognized hazards. Since any exposure to ionizing radiation is thought to incur some risk of cancer or genetic effects, the goal is to keep exposures low while allowing research with radioactive materials to proceed without undue hardship. The ALARA program uses the following methods to keep radiation exposures as low as reasonably achievable:

Training

All individuals are made aware of radiation effects and methods to keep exposures low. Laboratory demonstrations during training illustrate the principles of time, distance, and shielding through the use of actual sources and survey instruments. In addition, proper survey techniques are demonstrated so users can minimize any contamination that may have the potential to be inhaled or ingested.

Personnel Dosimetry

Although few individuals meet the requirement for external personnel dosimetry this service is provided to all users of energetic beta and gamma emitting radionuclides. This program allows Purdue to determine easily any problem areas that may be developing especially for users that lack extensive experience in handling radionuclides.

Exposure Notification

Exposure reports are usually reviewed by all members of the professional radiation safety staff. Subsequent to that review any exposure exceeding 100 millirem in any bimonthly period is identified. Exposures to the extremities, skin, and those to the whole body are included in this process. Individuals receiving doses exceeding this trigger limit are identified and notified of the exposure. This alerts the individual of the dose and the location (whole body, hand, etc.) receiving the dose. The individual is required to sign and return a form to confirm his awareness of the dose. The individual must also indicate the reason for the dose and indicate actions that will be taken in the future to reduce those exposures.

Exposure Investigations

When exposures exceed greater than 25 percent of the limits specified in 10 CFR 20.1201 an investigation into the causes is initiated. Procedures are examined and recommendations are made by health physicists to assist in reducing exposure to the affected individual(s). In many cases investigations proceed when users request assistance in keeping their exposures as low as possible even prior to reaching 25 percent of the applicable limits.

Laboratory Audits

Routine laboratory audits are an ideal method to informally observe procedures and activities in the laboratory. Independent measurements in the lab can also identify areas where shielding and placement of radioactive storage areas can reduce exposures to lab occupants even further.

11.0 Waste Management

All waste management operations at Purdue University are carried out by trained technicians. Technicians are responsible for picking up radioactive waste from all laboratories since researchers are prohibited from sink disposal or any other direct means of disposal unless specifically exempted from the requirements.

11.1 Containers

Containers for waste are supplied by REM unless a PI has requested to use alternative equivalent containers. The containers that are delivered to investigators upon request include the following:

Plastic carboys: up to 20 liters

Plastic drums: 5 gallons

Bags: 5 and 30 gallon plastic

Prior to pickup by REM, all containers must be properly labeled to include isotope, amount, authorization number, investigator name, date, and any solvents or hazardous materials present.

11.2 Segregation of Waste

Waste is required to be separated into a number of different categories so that it may handled. At this time the categories for waste include:

Solid short half-life (< 30 days) is placed into drums or bags as appropriate.

Long half-life material is separated into combustible and non-combustible and placed into bags or drums.

Liquid waste is separated into short and long half-life. Any liquid waste containing hazardous or non-dispersible components is identified and handled separately.

Vials are required to be returned to their original carton to remain upright during transport or placed in a drum which is double-bagged to prevent leakage.

Biological waste is placed in plastic bags and kept frozen until pickup.

Sharps are required to be in a rigid or semi-rigid container so that handling the container would prevent cuts or punctures to the technicians.

11.3 Pickup Procedures

When a PI is ready for a waste pickup REM is called to schedule the pickup. Technicians verify the label to ensure that all information necessary is complete. The packages are all smeared, surveyed for exposure rate at the surface and at 1 meter, and checked to see that the enclosures are secure. Any labeling, marking, notices, shipping papers, and placarding requirements are observed pursuant to 49 CFR prior to transport on public highways.

11.4 Waste Processing

After pickup waste is delivered to various handling facilities for processing and disposal. Description of those facilities is provided elsewhere in this application.

Short half-life materials are stored for a minimum of 10 half-lives prior to disposal. Solid material is surveyed with an end-window GM survey meter and any material with radiation levels essentially equal to background are disposed as normal trash. Prior to disposal all radioactive labels and markings are defaced or destroyed. A record of all radioactive material that has been disposed of by decay in storage (DIS) will be maintained. Liquid material will be sampled and analyzed for radioactivity by liquid scintillation counting. Any material less than 100 dpm/ml will be disposed in the sanitary sewer provided the material is readily dispersible and non-hazardous. If the activity is above this amount the material will be allowed additional decay time. If further sampling reveals that the activity is still present it will be treated as long half-life material (see below).

Combustible solid long half-life material will be incinerated at Purdue facilities using an incinerator described in our broad scope license. Procedures for loading waste and ash handling are also described therein. Short half-life material may also be incinerated provided that this material be allowed to decay for at least 10 half-lives.

Non-combustible long half-life waste (metal and glass) is compacted using Teledyne Industries compactor. The Teledyne compactor is equipped with an external air exhaust and HEPA filter which is monitored on an annual basis for activity and integrity.

No air sampling is done in the area since the most volatile compound undergoing compaction is I-125. Personnel bioassays, probably the most sensitive exposure indicator, have indicated a maximum dose equivalent of 13 millirem per year to the thyroid. This is less than 0.03% of the 50 rem occupational limit for the thyroid and falls well under our 100 mrem ALARA

trigger level. Direct radiation surveys and wipe testing of the areas are performed on a regular basis.

Long half-life liquid is sampled and analyzed according to the radionuclide(s) present. Pure beta emitters are analyzed by liquid scintillation counting and gamma emitters are analyzed by NaI or Ge spectroscopy. An activity is calculated and a computer program compares the activity with disposal limits and makes recommendations for disposal.

Liquid waste may be disposed of by the sanitary sewer as provided in 10 CFR 20.2003. Attempts are made to limit daily disposal to less than ten times the Appendix C value in the interest of ALARA. However, if this limit would increase exposure to radiation safety staff (such as subdividing waste packages) the former limits would be observed. Records are maintained at all times of material that has been disposed of in this manner.

Scintillation vials are packaged in drums and shipped via a waste broker for treatment or disposal. All applicable DOT regulations regarding the shipment of hazardous materials are observed.

11.5 Waste Shipments

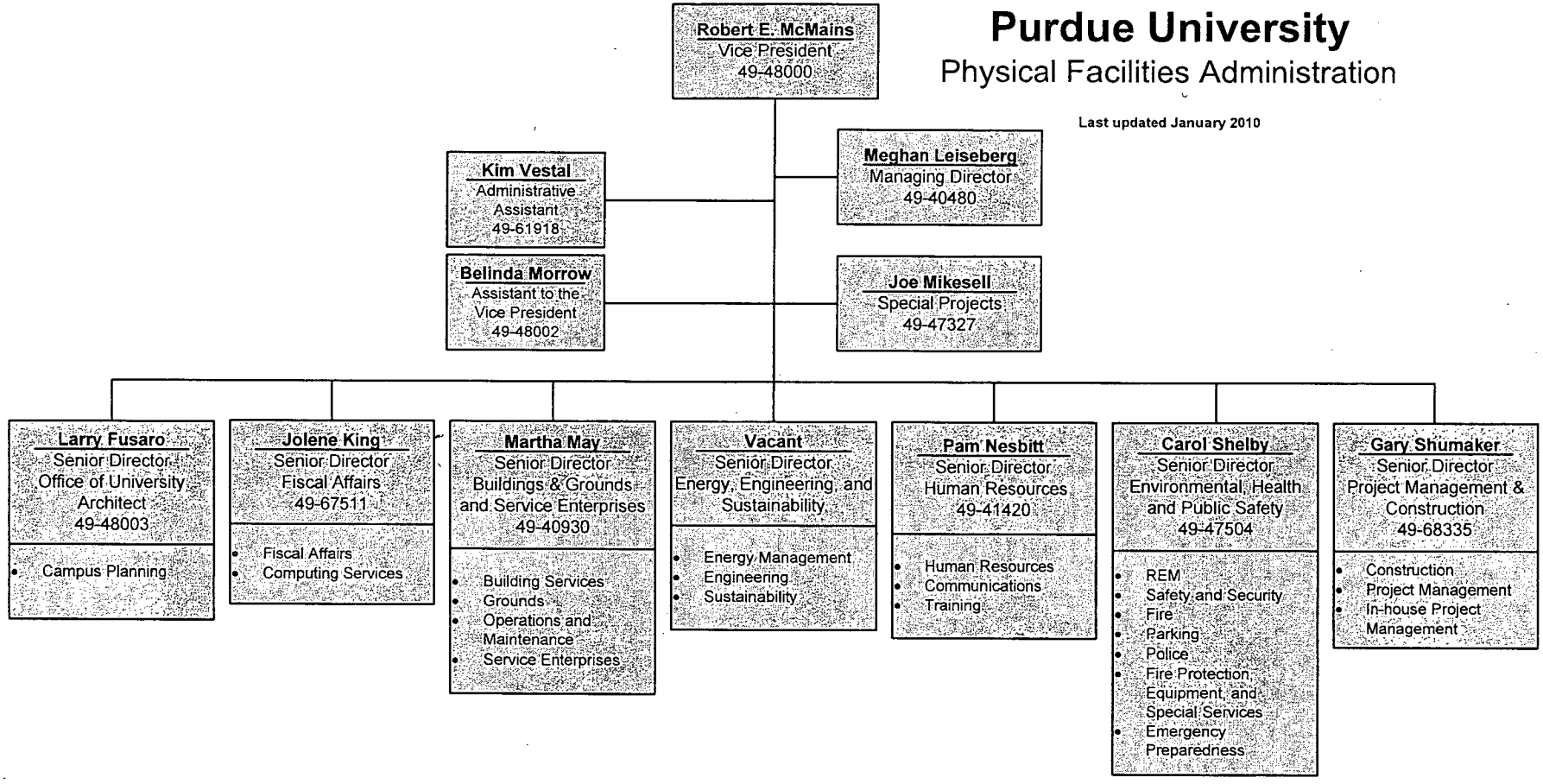
All waste shipments will be transferred to a licensed waste broker or facility. Currently waste is transferred to Bionomics. for ultimate disposal or treatment at licensed facilities. Sealed sources may also be transferred to other licensees for disposal or reuse such as J.L. Shepherd and Associates. In all cases, we follow Appendix F to 10 CFR 20.1001 to 20.2401 for land disposal of all wastes.

Attachment 7-1

Purdue University

Physical Facilities Administration

Last updated January 2010

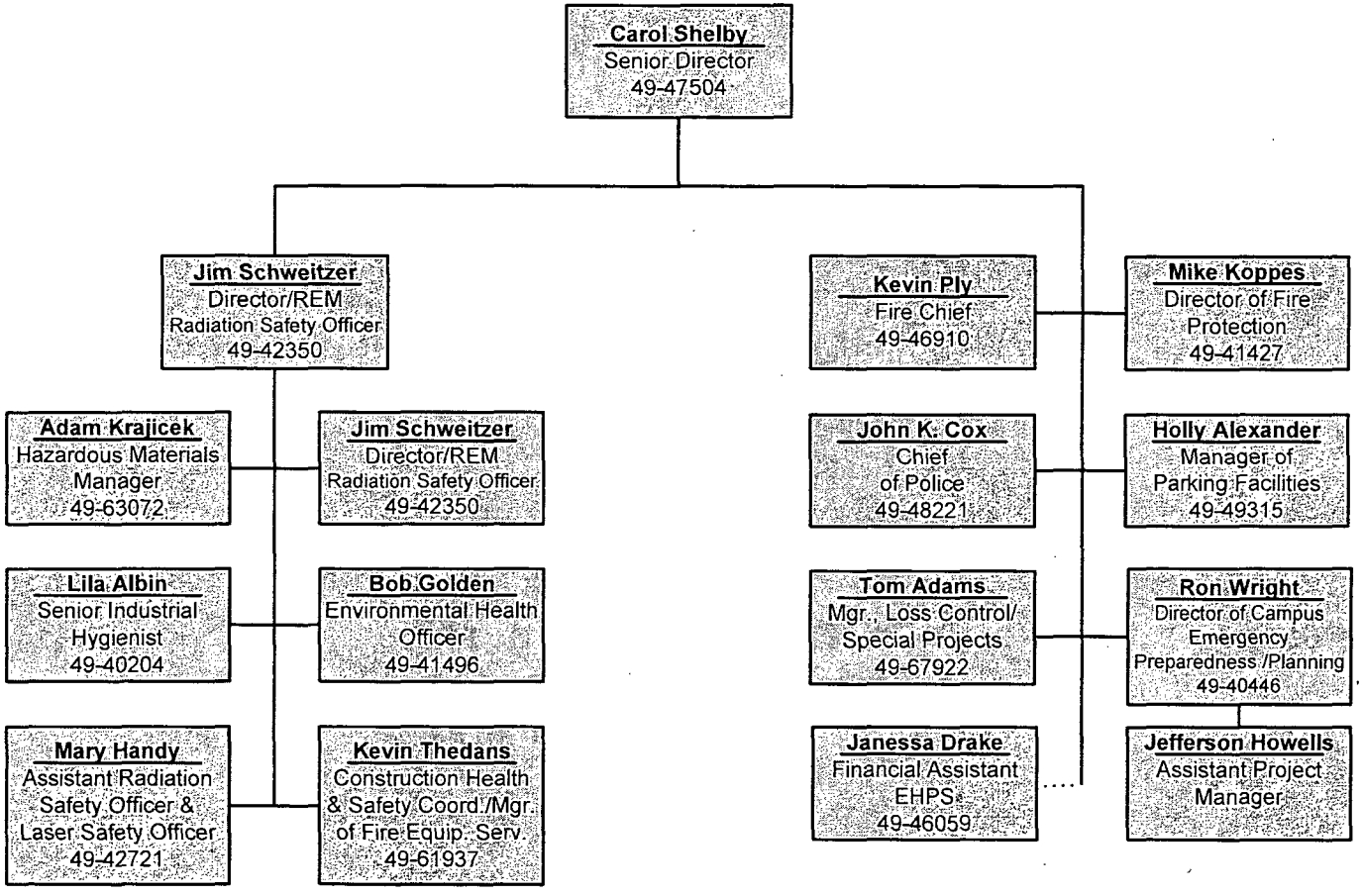


Purdue University

Physical Facilities

Environmental Health and Public Safety

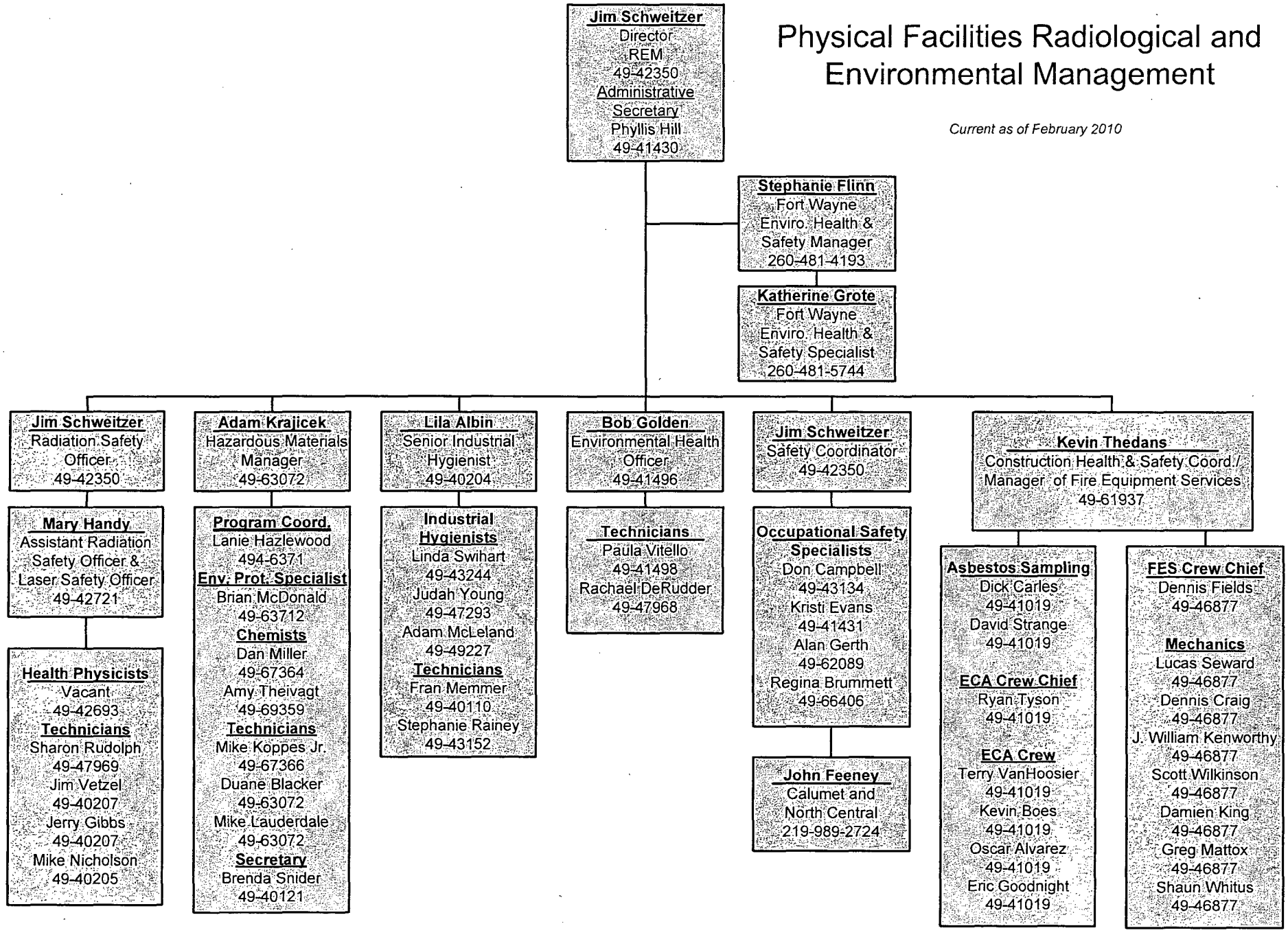
Current as of January 2010



Purdue University

Physical Facilities Radiological and Environmental Management

Current as of February 2010



PURDUE UNIVERSITY
OFFICE OF THE PRESIDENT
EXECUTIVE MEMORANDUM NO. B-14

(Supersedes Executive Memoranda No. B-14, dated May 15, 1973, A-50, A-54, and A-236)

August 1, 2001

To: Provosts, Vice Presidents, Deans, Directors, and Heads of Schools, Divisions, Departments, and Offices

Re: Composition, Duties, and Responsibilities of the University Radiation Safety Committee

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I. The mission of the Radiation Safety Committee is to ensure the safety of the University and community in the utilization of all radioactive materials and radiation producing devices at the University or by University faculty, staff, or students.

II. Definitions.
   a. For the purposes of this Memorandum, the University shall mean all teaching, research, and outreach programs conducted at any Purdue University campus and at any other Purdue operated property.
   b. Radioactive material refers to any solid, liquid, or gas that emits radiation spontaneously.
   c. Radiation, as used herein, refers to both ionizing and non-ionizing radiation including x-rays, gamma rays, alpha and beta particles, high speed electrons, neutrons, protons, other nuclear particles, and microwaves; but not including laser light.
   d. Radiological safety refers to the safe use and handling of radioactive materials or radiation in any application, including but not restricted to teaching, research, development, and medical diagnosis and therapy.

III. The Radiation Safety Committee (RSC) shall consist of faculty and staff, who by their knowledge and experience and under Nuclear Regulatory Commission (NRC) guidelines are qualified to make judgments and formulate policy in the areas of radiological safety. RSC members are appointed annually by the President upon the recommendations of the Vice President for Physical Facilities and the Vice President for Research in consultation with the various deans.

The chairman, a member of the faculty, will be appointed in a similar manner. The chairman will preside at the regular meetings of the committee, assure timely reviews of new projects, report as needed to the aforementioned vice presidents, and perform other duties as may be assigned by the committee.

The Head of Radiological and Environmental Management with the approval of the RSC will appoint the Radiation Safety Officer (RSO). The RSO should be an individual trained in the area of radiological science or health physics. The background of the RSO will be such that the individual is acceptable to the NRC as specified in the Draft Regulatory Guide dated April 1982, "Qualifications for the Radiation Safety Officer in a Large-Scale, Non-Fuel Cycle Radionuclide Program" or equivalent guidance. The RSO will report directly to the Head of Radiological and Environmental Management. The Head will be responsible for implementation and enforcement of policies and procedures promulgated by the Radiation Safety Committee. The Head and the RSO shall be *ex officio* members of the RSC but shall not hold the position of chairman of the committee.

IV. The specific duties and responsibilities of the Radiation Safety Committee include, but are not limited to:
   a. Assume responsibility, from the standpoint of radiological safety, for all University programs involving radioactive materials or radiation producing devices. This includes formulation of policy in this area and the establishment of safety standards.

b. Ensure that Radiological and Environmental Management provides faculty, staff , and students with appropriate training and information in the area of radiological safety and its applicable rules and regulations.
c. Review and approve or disapprove the use of radioactive materials or radiation producing devices within the institution from the standpoint of radiological safety. The committee may prescribe special conditions, requirements, and restrictions as may be deemed necessary to protect any person from hazards associated with radioactive materials and the operation or use of radiation producing devices on the Purdue University campus, and other Purdue operated properties. Such conditions, restrictions, and requirements shall in all cases be consistent with any existing federal or state regulations governing such use. Committee or interim approval of radiological safety measures must be obtained before any project involving radioactive materials or radiation producing devices is initiated. Special conditions may include but not be limited to: physical examinations, additional training, limited areas of use, disposal regulations, and posting requirements.
d. Establish policies under which the Head of Radiological and Environmental Management or the Radiation Safety Officer shall serve as the University's liaison with the Indiana State Department of Health, Indiana Department of Environmental Management, Nuclear Regulatory Commission, and Midwest Compact Commission in matters of registration, licensing, radiological health and radioactive or mixed waste disposal.
e. Keep a record of the actions taken in approving the use of radioactive materials and radiation producing devices and of other transactions, communications, and reports involved in the work of the committee.
f. Submit an annual report detailing the activities of the committee to the Vice President for Research and the Vice President for Physical Facilities.

V. Actions taken by the Radiation Safety Committee may be appealed by the staff member or department concerned through the appropriate Vice President to the President of the University for final decision, with the knowledge and consent of the dean or director of the school involved, and knowledge of the chairman of the Radiation Safety Committee.

VI. The chairman of the committee or the RSO, or their duly authorized representatives, are authorized to act (under policies established by the committee) for the committee between meetings (interim approval), reporting actions taken to the committee for review at appropriate intervals.

/II. The RSO or his/her designee, consistent with the protection of University employees, students, visitors, the public, and the environment, is authorized to:
a. Carry out unannounced inspections and radiation surveys of any University facility.
b. Order immediate shutdown or cessation of work in any facility where it is evident that safety hazards exist to the extent of endangering health, safety, property, or to the extent that continued operation would result in any violation of existing federal, state, or University regulations.

Martin C. Jischke
President

Purdue University Radiation Safety Committee

Mark A. Green	Professor, Industrial & Physical Pharmacy/RHPH, School of Pharmacy, Purdue University (Chairman)
John N. Anderson	Professor, Biological Sciences/LILY, School of Science, Purdue University
Robert R. Landolt	Professor, Health Sciences/CIVL, School of Pharmacy, Purdue University
Christine A. Hrycyna	Associate Professor, Chemistry/BRWN, School of Science, Purdue University
Jere H. Jenkins	Director, Radiation Laboratories, Nuclear Engineering/NUCL, Schools of Engineering, Purdue University
Glenn J. Merkel	Adjunct Assistant Professor, Biology/IUPU at Fort Wayne
Steven R. Scofield	Assistant Professor, Agronomy/LILY, School of Agriculture, Purdue University
Mary J. Handy	Health Physicist, Radiological and Environmental Management, Purdue University, committee secretary
James F. Schweitzer	Assistant Professor/Health Physics, Director, Radiological and Environmental Management/CIVL, Purdue University, ex-officio
Carol A. Shelby	Senior Director, Environmental Health and Public Safety/LMSB, Purdue University, ex-officio
Paul L. Ziemer	Professor, Health Sciences/CIVL, School of Pharmacy, Purdue University
David S. Koltick	Professor, Physics, PHYS, School of Science, Purdue University

PURDUE UNIVERSITY

RADIATION SAFETY MANUAL

December 12, 2006

Purdue University
Radiological and Environmental Management
1662 Civil Engineering Building, Room B173
West Lafayette, Indiana 47907-1662
(765) 49-46371

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1.0 REGULATION

1.1 Radiation-Producing Devices

The use of radiation-producing devices is regulated by the State of Indiana. The State Department of Health is responsible for the promulgation and enforcement of rules concerning the inspection of machine-produced radiation such as diagnostic and therapeutic x-ray machines, analytical x-ray units, electron microscopes, and particle accelerators. Regulations can be found in the Title 410 Part 5 of the Indiana Administrative Code.

1.2 Radioactive Materials

The possession and use of radioactive materials is governed mainly by federal regulations. The Nuclear Regulatory Commission (NRC) under Title 10 of the Code of Federal Regulations (CFR) regulates the use of byproduct material, source and special nuclear material, and reactor operations. The State of Indiana regulates accelerator produced radioactive material and naturally occurring radioactive material. Nearly all of the radioactive material used at Purdue University falls under a broad scope license issued by the NRC. This type of license differs from a specific license in that Purdue University is granted the authority and responsibility to set specific conditions of use within the institution. However, these conditions must be compatible with state and federal regulations, representations made to the NRC, and specific license conditions. The broad scope license number is 13-02812-04 and is scheduled for renewal on a periodic basis.

Purdue University also possesses three additional NRC licenses. These regulate the use of source material (uranium), special nuclear material (enriched uranium), and research reactor operations.

During application for these licenses, procedures and operating conditions are specified to the NRC as part of the license. Any significant changes to these conditions require written approval prior to the initiation of any work. Examples of changes that would require an NRC amendment are: acquisition of radioactive material exceeding currently licensed activity limits, use of radioactive materials in the environment (field studies), use of radioactive material at off-campus locations, and the use of radioactive materials in humans. If new research involves novel applications or work listed above, please allow four to six months for the amendment approval process.

1.3 Radiation Safety Committee

The use of radioactive materials and radiation-producing devices is regulated at Purdue University by the Radiation Safety Committee (RSC). The RSC is composed of faculty and staff who by their knowledge and experience are qualified to make judgments in the area of radiation safety in accordance with Executive Memorandum B-14 (August 1, 2001).

The policies and procedures established by the RSC are carried out by the Director of the Department of Radiological and Environmental Management (REM) through the Radiation Safety Officer (RSO). The RSO is responsible for day to day operations and reports to the RSC at regular intervals (quarterly).

2.0 AUTHORIZATION FOR USE OF IONIZING RADIATION SOURCES

All new uses of radioactive material or radiation-producing devices and major changes in existing authorizations must be approved by the Radiation Safety Committee (RSC). Preliminary project review is conducted by REM. Upon recommendation of the RSO, the RSC may grant interim approval of the project. Final approval is granted at quarterly meetings of the RSC.

2.1 Application Procedures

In order to receive authorization for use of radioactive material or radiation-producing devices, the principal investigator must complete a Form A-1. All forms can be obtained using the Radiological and Environmental Management web site (http://www.purdue.edu/rem). The application must contain the following information:

- **Items 1-4:** Principal investigator information.
- **Item 5**: All personnel requesting approval to use radioactive material or radiation-producing devices must be listed. Each individual (including principal investigator) must also submit a Form A-4 signed by the principal investigator and must attend the required radiation safety training.
- **Item 6:** All proposed use areas for radioactive materials or radiation-producing devices must be listed. This includes "common" areas that may be shared with other investigators such as counting rooms. Complete a Form A1-S for each area requested.
- **Item 7:** Each isotope and compound requested must be listed with appropriate experimental, order, and storage limits. Each radiation-producing device must be listed.
- **Items 8 thru 11**: A complete description of the experimental protocol and procedures must be submitted for evaluation by the Radiation Safety Committee. A reprint of a journal article will suffice in most cases. Failure to provide complete information may delay consideration and approval of the application.
- **Items 12 thru 15**: Indicate precautions and practices to be implemented to assure contamination control and security of radioactive material. For use of high-energy beta emitters and gamma emitters, a survey meter with an end window G-M probe will be required. (Submit Form SM-1 and have initial calibration of meter performed by REM). Sign the application.

The addition of new personnel or use areas to an existing project requires the submission of a Form A-4 or Form A1-S, respectively. The addition of new isotopes or procedures requires the submission of a Form A-1.

3.0 TRAINING REQUIREMENTS

Current regulations require that individuals using sources of ionizing radiation, including the principal investigator, have appropriate training prior to the initiation of any work. Basic training in the areas of radiation safety and emergency procedures is provided by REM.

Training in policies and procedures at Purdue University is also covered in this initial training session. Training in specialized procedures or techniques must be provided by the principal investigator or his designee. No work is allowed to begin unless the individual has received all the appropriate training. Continuing education (retraining) is also required at appropriate intervals in order to maintain authorization to work with radioactive materials.

The principal investigator must demonstrate that he or she has the appropriate training and experience with the types and quantities of radionuclides requested. When, in the judgment of the Radiation Safety Committee, an applicant does not have the requisite training and experience to act as the principal investigator, the applicant may be required to work under the supervision of an approved investigator until this experience is obtained.

3.1 Training Sessions

Please contact REM to ensure you get the appropriate training for your needs. The following types of Radiation Safety Training sessions are offered:

- Unsealed radioisotopes with the potential for contamination (i.e. ^{3}H, ^{32}P, ^{35}S, etc.)
- Sealed sources with no potential for contamination (i.e. ^{60}Co, ^{137}Cs, etc.)
- Analytical X-ray use
- Diagnostic X-ray use (PUSH and School of Veterinary Medicine)
- Gamma irradiator use
- Nuclear gauge use and DOT requirements

4.0 RESPONSIBILITIES OF THE PRINCIPAL INVESTIGATOR

The principal investigator (the individual to whom the authorization for use of radioactive materials or radiation-producing devices has been issued) is responsible for all activities conducted under the scope of that authorization. These responsibilities include ensuring that:

1. All individuals are authorized, appropriately trained, and receive proper supervision for work with radioactive materials or radiation-producing devices.
2. All activities are conducted within the scope of the authorization and any representations made to the Radiation Safety Committee or its designee.
3. All rules, regulations, and procedures for the safe use of radioactive material and radiation-producing devices are followed.
4. Accurate records regarding the amounts, types, and locations of radioactive materials and radiation-producing devices are maintained.
5. Radiological and Environmental Management has approved any changes in use or location of radioactive material or radiation-producing devices prior to implementation of such changes.

5.0 PROCUREMENT OF RADIOACTIVE MATERIAL

Purdue University is required to control the acquisition of radioactive material and maintain an accurate inventory. Therefore, all materials must be approved by and ordered with appropriate REM approval. The principal investigator should determine that he or she is authorized to use the amounts and isotopes prior to the initiation of an order.

5.1 Ordering Radioactive Material

To request an order, a complete Form R-1 (Radioactive Material Requisition) must be submitted electronically by attachment to the requisition request. Make sure all account numbers, authorization numbers, and specifications for the material are complete. Indicate the date desired and any other special information. Incomplete requests may delay processing the order.

REM verifies the amount requested with the order and storage limits for which the user is authorized. If satisfactory, REM will approve the order. For additional ordering details, please visit the Radioactive Materials Purchasing page on the REM web site.

5.2 Receipt of Radioactive Material

All radioactive materials received at Purdue University must be delivered to REM. Materials received will be processed to check for proper isotope and form, exposure rate, and any gross contamination. Inner vials are not surveyed for contamination; therefore, these containers should be handled as if they were contaminated.

After processing, the material is delivered to the laboratory. Upon receipt, the user is responsible for maintaining accurate inventory records for all radioactive material possessed.

6.0 TRANSFER OF RADIOACTIVE MATERIAL

The transfer of radioactive material to another project or licensee (other than properly disposed waste) must be approved by REM prior to transfer of the material. Transport of radioactive or hazardous material must be in compliance with all DOT regulations. Contact REM for information on transportation regulations.

6.1 On-Campus Transfer

Transfer of radioactive material to another user will usually be approved if the receiving individual has authorization to possess that type and amount of radioactive material. A memo or a Form R-1 stating the persons, isotope, form, and amount involved in the transfer must be submitted when the transfer takes place.

6.2 Off-Campus Transfer

Current regulations allow the transfer of radioactive material to holders of current licenses with the Nuclear Regulatory Commission or an agreement state. Prior to transfer, Purdue must have written verification that the facility holds a valid license to possess radioactive material. REM will ship material upon request to ensure that proper packaging and labeling requirements are met.

Any transfer to Purdue University from a non-vendor source (gift, joint research) will be handled in the same manner as that from a vendor source. The material must be shipped to REM, and the user will be notified upon receipt.

7.0 RADIOACTIVE WASTE HANDLING

REM is responsible for collection, management, and disposal of all radioactive waste at Purdue University. The disposal of radioactive material via the sanitary sewer or regular trash receptacles is prohibited. Posters outlining waste handling procedures are placed in laboratories on campus. Some general points to follow are outlined below:

1. Radioactive waste (both solid and liquid) must be segregated according to half-life. Short half-life material (less than 30 days) such as ^{32}P must be separate from ^{3}H, ^{14}C, and ^{35}S.
2. Solid waste (other than short half-life) must be separated according to its combustibility. Paper, cardboard and plastics are incinerated while metal and glass are compacted and shipped for disposal. Sharp items such as needles, razor blades, and Pasteur pipettes must be placed in a box or a "sharps" container to prevent injury during subsequent handling of the waste. Lead containers must be segregated from other solid waste.
3. Liquid organic waste and aqueous waste must be collected separately. Scintillation media in vials should be placed in the original carton or packed to prevent leakage of the liquid in transport.
4. Radioactive animal carcasses, viscera, or other biological materials subject to putrefaction must be placed in a plastic bag and frozen prior to pickup.
5. If possible, the mixing of hazardous chemicals and radioactive materials should be avoided. So called "mixed waste" which contains radioactivity and a component which exhibits corrosivity, reactivity, toxicity, etc. can have significant handling and disposal problems. If these materials must be mixed together, contact REM for assistance in developing procedures to minimize the generation of this type of waste.
6. All radioactive waste must be properly labeled with authorization number, isotope(s), amount(s) and the date sealed. Under no circumstances will waste be picked up if the label is not complete. For assistance concerning unique situations, contact REM. All containers (i.e. bags, carboys, etc.) are supplied by REM.

Completed Radioactive Waste Pickup requests may be submitted by the following means:

- Web submission form
- Fax the Microsoft Word form to 49-47403
- Send the Microsoft Word form via campus mail to REM, CIVL

Waste pickup request submitted before 5:00 pm on Monday will be picked up on Tuesday.

8.0 PERSONNEL EXPOSURE AND MONITORING

The personnel monitoring program at Purdue University is designed to keep exposures to ionizing radiation "As Low As Reasonably Achievable" (ALARA). To this end, all personnel with the potential for receiving significant exposure from high-energy beta or gamma emitters are required to wear appropriate dosimeters. Dosimeters are provided at no cost to the individual. The individual, however, is responsible for prompt return of the dosimeters at the end of each wear date, even if the dosimeter was not worn during that period.

8.1 Occupational Exposure Limits

The current exposure limits in an occupational setting have been established for two reasons. The first is to prevent acute effects (i.e. erythema, epilation, etc.) and the second is to reduce late effects such as cancer and genetic damage to very low levels. The limits for occupational exposure can be found in Title 10, Part 20 of the Code of Federal Regulations (10 CFR 20). Table 1 provides a summary of these limits.

Table 1: Occupational Exposure Limits

	rem*/year
Total Effective Dose Equivalent (Whole Body)	5.0
Committed Dose Equivalent to any Organ	50.0
Eye Dose Equivalent	15.0
Shallow Dose Equivalent (Skin) or Extremity	50.0

*1 rem = 1000 millirem

Limits for internal exposure to radionuclides through air and water are addressed by the annual limit on intake (ALI) values in Appendix B of 10 CFR 20.

8.2 Exposure Limits for Pregnant Workers

The increased sensitivity of rapidly-dividing cells makes the human embryo and fetus more susceptible to injury from exposure to ionizing radiation. For this reason, the National Council on Radiation Protection and Measurements (NCRP) recommends and NRC regulations require that exposure to the worker (fetus) during the gestation period not exceed 500 millirem (one-tenth of the occupational limit). Regulatory Guide 8.13, published by the Nuclear Regulatory Commission, outlines health risk estimates associated with radiation exposure and means to reduce risks. This guide is distributed to all workers during initial training sessions.

8.3 Non-occupational Exposure

The limit for whole-body exposure to the general public and workers not approved to use sources of ionizing radiation is 100 millirem (one-fiftieth of the occupational limit). This exposure is in addition to that received by an average individual from naturally occurring background radiation (approximately 200 millirem/year) and medical exposures (100 millirem/year).

8.4 Personnel Radiation Dosimetry

External exposure to gamma, x-ray, and high-energy beta radiation is monitored by devices called dosimeters. At Purdue University, film badges are used to measure whole-body exposure. The dosimeter consists of a strip of film that is sensitive to ionizing radiation. The dosimeters must be returned monthly and processed to determine the amount of darkening. The exposure is directly proportional to the amount of darkening.

Ring badges usually contain a small chip of thermoluminescent material such as LiF or CaF_2. The thermoluminescent dosimeter (TLD) absorbs a portion of the energy of ionizing radiation. When the TLD is heated, the energy is released in the form of light which is proportional to the radiation exposure.

To provide accurate estimates of radiation exposure, the dosimeter must be worn properly when working with radioactive materials or radiation-producing devices. The film badge should be worn on the collar, pocket, or belt area. If a shielded apron is worn, the dosimeter should be worn outside the apron. The ring dosimeter should be worn with the sensitive area (label) on the palm side of the hand. Fetal dosimeters should be worn on the abdominal area.

Only individuals using certain radioisotopes and amounts are provided with dosimetry. If a film badge or ring is required it will be provided to you at the time of your initial work.

8.5 Bioassay

Bioassays are performed to assess the amount of radioactive material that has been taken into the body through inhalation, ingestion, or absorption through the skin. The bioassay is commonly performed by taking a sample of a body fluid such as urine. The amount of radioactivity in the sample is determined and the resulting internal dose to the individual calculated. Thyroid bioassays can be performed using an external probe. The amount of radioactivity in the thyroid is assessed and the resulting internal dose calculated.

In general, urinalyses are performed only when large amounts of volatile radioisotopes are used or when there is a suspected significant uptake of radioactive material. Thyroid bioassays, however, are performed routinely on individuals performing radioiodinations and using radioiodines on a regular basis. This program is designed for early identification of significant uptakes of radioiodines as part of Purdue University's ALARA program.

8.6 Personnel Exposure Records

Radiation exposure records for personnel are maintained by REM. These records are available to the individual upon written request.

The goal of ALARA is to keep radiation exposures as low as possible. Therefore, REM sends a Form F-1 to an individual receiving greater than 100 millirem to the whole body or extremities during any wear period. The Form F-1 must be completed and returned to REM to acknowledge the exposure and to provide an explanation for the exposure. Although exposures at approximately 100 millirem are not excessive, awareness of these exposures is important.

9.0 LABORATORY SAFETY

Although the potential hazards of working with radioactive materials may be significant, proper facilities and the observance of laboratory safety rules can keep risks to a minimum.

9.1 Facilities

In general, a properly designed chemical laboratory will be adequate to serve the needs of radioisotope users. Specific research may require the use of specially designed facilities to minimize the hazards associated with that particular research. Procedures that differ significantly from those approved in the past must be approved by the Radiation Safety Committee.

As a minimum, radioisotope laboratories should have the following properties:

1. Smooth, non-porous floors and walls that can easily be cleaned in the event of spills or contamination.
2. Smooth non-porous lab benches that can easily be decontaminated. Porous surfaces must be covered with absorbent paper or work done in an appropriate spill tray.
3. When required, laboratory fume hoods and ventilation systems must be of the appropriate design and construction for the hazard.
4. The facility should be easily isolated from general personnel access areas such as hallways and office areas. The areas should have locks or some means to prevent access and unauthorized use of radioactive materials when personnel are not in attendance.
5. Appropriate shielding and/or interlocks to prevent personnel access must be used when radiation levels would present undue hazards to personnel or the general public. (Note that exposure rates greater than 5 mR/hr require posting as a "radiation area" and levels in unrestricted areas cannot exceed 2 mR/hr).

9.2 Procedures and Rules for the Safe Use of Radioactive Material

1. Eating, drinking, food preparation, food storage, and application of cosmetics are not permitted in laboratories where significant amounts of unsealed radioactive materials are stored or used. Consumption of beverages may be permitted in Type C labs during periods of time when the user is not actually handling or using radioactive materials. The storage or preparation of food or beverages, the consumption of food, and the application of cosmetics is not permitted in a Type C laboratory. The consumption of food and beverages and the application of cosmetics may be permitted in a Type D laboratory when the user is not actually handling or using radioactive materials. Storage of food and beverages is not permitted in the same storage location (i.e. refrigerator, cabinet, etc.) as the radioactive materials.

   Most radioisotope laboratories are also chemical laboratories subject to the Purdue Chemical Hygiene Plan. Under those guidelines, drinking, eating, and the application of cosmetics is forbidden in areas where hazardous chemicals are in use.
2. The use of food containers for handling or storing radioactive materials is not permitted. Any other containers used must be clearly marked as containing radioactive material.
3. The pipetting of radioactive solutions by mouth is strictly prohibited.
4. A trial run without radioactive material must be conducted for all new procedures. Radioactive material may be used only after the safety of the procedures has been assured.
5. Any work performed with volatile material (such as sodium iodide) or operations that have a potential for personnel exposure or contamination must be performed in an appropriate hood or glove box. New procedures involving these types of materials must be approved by the Radiation Safety Committee prior to initiation.
6. Protective equipment such as gloves and lab coats must be used for all manipulations of unsealed sources. In addition, eye protection must be worn when working with materials that could be hazardous to the eyes. Eye protection is also required when handling greater than 10 millicuries of high-energy beta emitters such as P-32.
7. Protective equipment must not be worn outside the laboratory unless it has been monitored and found to be free of contamination. Gloves, while providing protection to the user, can spread contamination if worn outside the laboratory.
8. All work surfaces must be covered with absorbent paper that is changed on a regular basis. Work with large volumes of material and/or material with high spill possibility must be done in an appropriate spill tray.
9. A radiation survey must be performed by the radionuclide user at the end of each procedure involving radioactive materials. The survey may be conducted with a portable survey instrument or wipes as appropriate. All items found to be contaminated should be placed in a

suitable area or disposed of as radioactive waste. Any radioactive contamination found must not be allowed to remain in any area for an extended period of time. If contamination is found outside the immediate use area, REM should be notified immediately.

10. Radioactive material use, survey, and inventory records must be maintained at all times by the principal investigator

9.3 Inspections and Postings

Radioisotope laboratories are classified and inspected according to their relative hazard. This classification takes into account the radioisotope, amount used and stored, chemical form, and types of procedures performed in the laboratory. The classification scheme and inspection frequency is listed below:

Table 2: Laboratory Inspection Scheduled (by Hazard)	
Class A (High)	Weekly
Class B (Moderate)	Monthly
Class C (Low)	Quarterly
Class D (Very Low)	Yearly

The purpose of the inspections and laboratory audits conducted by REM is to verify that activities at Purdue University are conducted within the scope of the NRC license and applicable state and federal regulations and conditions approved by the Radiation Safety Committee. These inspections do not take the place of routine surveys conducted by laboratory personnel or waive the requirement to maintain records.

All laboratory areas must be posted with a "Caution-Radioactive Materials" label. These labels are posted by REM once an area is approved for radioactive material use. After an area is no longer needed and radioactive materials are removed, the room will be decommissioned and the label removed by REM.

10.0 EMERGENCY PROCEDURES

Emergencies resulting from accidents in radioisotope laboratories may occur even though all laboratory rules are obeyed. Because of numerous complicating factors, set rules of emergency procedure cannot be made to cover all possible situations. In any situation, the primary concern is protection of personnel from physical and radiation hazards. The secondary concern is confinement of any contamination to the immediate area.

10.1 Minor Accidents

Accidents involving small quantities of radioactive material in non-volatile form confined to a small area can usually be regarded as minor.

1. Notify all other persons in the room at once.
2. Exclude persons not directly involved in the dealing with the spill.

3. Confine the spill immediately.
    - **Liquids:** Drop absorbent paper or material on spill.
    - **Solids:** Dampen thoroughly using small quantities of water, taking care not to spread contamination. Use water unless it would generate an air contaminant. Oil should then be used.
4. Notify the laboratory supervisor and Radiological and Environmental Management at 49-46371.

10.2 Major Accidents

Accidents occurring outside a hood involving volatile material or accidents involving large (millicurie) amounts should be considered major. Discovery of any widespread contamination should also be considered major.

1. Notify all persons in the room and take steps to evacuate the area.
2. Rinse off skin by flushing with water and remove contaminated clothing if applicable.
3. Secure the room and prohibit entry to the contaminated area.
4. Immediately notify the laboratory supervisor and Radiological and Environmental Management at 49-46371. During off hours or if REM cannot be reached contact the University Police at 49-48221.
5. Assemble those persons involved near the laboratory entrance and wait for assistance.

10.3 Fire and Fire-Related Emergencies

If you discover a fire or fire-related emergency such as abnormal heating of material, hazardous gas leaks, hazardous material or flammable liquid spill, smoke, or odor of burning, immediately follow these procedures:

1. Activate the building fire alarm system (fire pull station). If not available or operational, verbally notify persons in the building.
2. Notify the Fire Department at 911.
3. Isolate the area and evacuate the building:
    - Shut down equipment in the immediate area, if possible.
    - Close doors to isolate the area.
    - Use a portable fire extinguisher to control a small fire or assist in evacuation if possible.
4. Provide the fire/police teams with the details of the problem upon their arrival. Special information you know may be helpful in mitigation of consequences due to radioactive materials.
5. Notify Radiological and Environmental Management at 49-46371.

10.4 Injury

All employees and students must notify their immediate supervisor or instructor of all injuries related to exposure to radioactive materials. Each individual should report to the Purdue University Student Hospital if medical attention is required. An appropriate injury report must also be filed.

In the case of a serious injury:

1. Administer any life-saving procedures without regard for contamination.
2. Do not move a seriously injured person unless he or she is in further danger.
3. Telephone the University Police for ambulance assistance at 911.
4. Notify Radiological and Environmental Management at 49-46371.

APPENDICES

APPENDIX A1: References

APPENDIX A2: Form A-1 (Radiation Project Approval Request)

APPENDIX A3: Form A1-S (Radiation Facility Approval Request)

APPENDIX A4: Form A-4 (Application to Use Radioactive Materials and/or Radiation Producing Devices)

APPENDIX A5: Form F-1 (Notice of Dosimetry Exposure)

APPENDIX A6: Form R-1 (Radioactive Material Requisition)

APPENDIX A7: Form SM-1 (Survey Meter Inventory)

APPENDIX A8: NRC Form 3 (Notice to Employees)

APPENDIX A9: Waste Handling Poster

APPENDIX A1: References

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APPENDIX A2: Form A-1 (Radiation Project Approval Request)

REM FORM A-1
Revised 4/06

PURDUE UNIVERSITY.

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

Radiation Project Approval Request

Summary & Evaluation for Use of Radioactive Materials or Radiation Producing Devices

☐ New Project
☐ Amendment Authorization Number:_____ Date:_____

1. Project Director: _____ 2. Department: _____

3. Position: _____ 4. Phone: _____

5. Requested Users: (*Attach Form A-4 for each user - use back of page for additional names*)

	Name	Department	Position
a.)			
b.)			
c.)			
d.)			

6. Requested Locations of Use: (*Attach Form A1-S for each room*)

	Building	Room	Building	Room
a.)			b.)	
c.)			d.)	

7. Radioactivity to be used:

	Nuclide	Chemical Form	Max mCi/Exp	Max mCi/Order	Storage (mCi)
a.)					
b.)					
c.)					
d.)					
e.)					
f.)					
g.)					

8. Radiation to be produced by device:

	Type of Radiation	Manufacturer/Model Number	KVP	mA
a.)				
b.)				
c.)				

Page 1 of 3

9. Provide a brief outline of the purpose of the project.

10. Give detailed methods and procedures to be used in the project:
(A journal reprint or a copy of written procedures should be attached)

11. Indicate any reactions which will change the form of the labeled material. Give initial form and the major labeled end products.

12. Is there any chance radioactive gas or particulates will be formed? If so, what method will be used to prevent inhalation of radioactive material and what activity could potentially be released to the atmosphere?

13. Note instrumentation and methods to be used to ascertain that contamination has not spread into uncontrolled areas:
(Include manufacturer, model, and range for radiation monitoring devices and attach a Form SM-1 for each device)

14. Indicate storage and experimental containment areas to assure that dose rates are kept as low as reasonably achievable: *(Specify the design, thickness, and type of shielding material)*

15. Specify precautions and procedures to be used by personnel to:

Keep exposures as low as reasonably achievable?

Prevent unauthorized removal or use of radioactive material or radiation producing devices?

Prevent contamination and excessive exposure rates in work areas and in adjacent area?

16. Will animals or plants be used? ☐ Yes ☐ No **If Yes:**

Type of animals or plants to be used: _____ Avg. Wt.: _____

Total number of animals or plants to be used: _____ Avg. Wt.: _____

Route of nuclide administration: _____

Do you anticipate the radioactivity to be contained in animals' exhaled air? ☐ Yes ☐ No

Do you anticipate the radioactivity to be contained in animals' urine? ☐ Yes ☐ No

Do you anticipate the radioactivity to be contained in animals' feces? ☐ Yes ☐ No

17. If animals are used, is protocol approved by Animal Care and Use Committee? ☐ Yes ☐ No

18. If hazardous chemicals are used, has the form Report These Materials been submitted to REM? ☐ Yes ☐ No

---

I certify the provided information is true and correct to the best of my knowledge and belief. The required forms (A-4, A1-S, SM-1) and procedures are attached.

Project Director Signature: _____ Date: _____

Approval Recommended:
Radiation Safety Officer: _____ Date: _____

APPENDIX A3: Form A1-S (Radiation Facility Approval Request)

PURDUE UNIVERSITY

REM FORM A1-S
Revised 4/06

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

Radiation Facility Approval Request

Class: _____
For Office Use Only

☐ New Project
☐ Amendment

Authorization Number: _____ Building: _____ Room: _____

Floor Covering: _____ Wall Coating: _____ Bench Top Material: _____

Number of hoods in facility: _____ Are the hoods to be used for radionuclide experimentation? ☐ Yes ☐ No

Monitoring Device: *(Additional monitoring devices may be listed on back.)*

Manufacturer: _____ Model: _____ Serial Number: _____ Purdue Number: _____

Storage Location: _____

Laboratory Usage: *(Check and fill in appropriate spaces)*

	☐ Nuclide (1/Line)	☐ Experimentation (Max mCi/Exp)	☐ Storage (Max mCi)	☐ Teaching (Max mCi/Exp)	☐ Counting (Type)
1.					
2.					
3.					
4.					
5					
6					
7					

	Devices	kVp	mA	Configuration *(open, closed, cabinet, medical)*
1.				
2.				

Are all personnel working in the facility approved radiation workers? ☐ Yes ☐ No

Is the lab also used for a study/office area? ☐ Yes ☐ No

Do you share the lab with other radiation project directors? ☐ Yes ☐ No

Individual submitting this request: _____ Date: _____

Project director in charge of radiation hazard control: _____
Signature

Approved by REM: _____ Date: _____

Sketch Facility: Authorization Number:_____ Building:_____ Room:_____

Draw a sketch of the facility and outline in red those areas where radionuclides are to be used and/or stored.

APPENDIX A4: Form A-4 (Application to Use Radioactive Materials and/or Radiation Producing Devices)

PURDUE UNIVERSITY

REM FORM A-4
Revised 4/06

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

Application to Use Radioactive Materials and/or Radiation Producing Devices

IMPORTANT: *Applicant must attend the training and submit this application to be authorized for using radiation. Previously authorized applicants at Purdue should indicate their previous project director's name:* _____

Was a film badge issued? ☐ Yes ☐ No

For Office Use Only

Authorization #: _____

FB: _____ R: ___

PLEASE PRINT CLEARLY:

Last Name | First Name | Middle Initial | Maiden Name

Position | Department | Building & Room | Telephone Number

Birth Date (Month/Day/Year) | Purdue ID Number | Email Address

I hereby request authorization to use the following radioactive materials and/or radiation producing devices as set forth in the project summary (Form A-1) beginning on _____
(Estimated Staring Date)

Isotopes
(See H-3 Example)

Isotope:	*H-3*				
Qty./Exp. (mCi):	*0.01*				

Radiation Producing Devices
(Check All That Apply)

Analytical X-ray	Medical/Veterinary X-ray	Accelerator
Open Beam ☐	*DEXA* ☐	
Closed Beam ☐	*Diagnostic Radiography* ☐	*Veterinary Therapy* ☐
Cabinet ☐	*Fluoroscopic* ☐	*Tandem* ☐

STATEMENT OF TRAINING AND EXPERIENCE

☐ **No Previous Training or Experience with Using Radioactive Materials and/or Radiation Producing Devices**
(Go to # 2 on the Next Page)

1. Type of Training (Check Appropriate Column)

	Formal Course	On-The-Job	Neither
Principles and Practices of Radiation Protection	☐	☐	☐
Radioactivity Measurement, Monitoring Techniques, and Instruments	☐	☐	☐
Mathematics and Calculations Basic to the Use and Measurement of Radioactivity	☐	☐	☐
Biological Effects of Radiation	☐	☐	☐

2. **Formal Courses - Do Not Include Purdue Radiation Safety Training** (List all courses taken for credit pertaining to the use of radiation or radioactive materials such as radiochemistry, radiation biology, nuclear engineering, etc.)

Title of Course	Where Trained	Duration	Course Content

3. **Experience** (List actual use of radioactive materials, radiation producing devices, details of formal laboratory courses, on-the-job training, etc).

Isotope	Maximum Used (mCi)	Where Gained	Duration	Type of Use

4. **Occupational Radiation Exposure History** (Previous employers, including Purdue, involving radiation exposure)

Name and Address of Employer and Department	Dates of Employment (From - To)

☐ **No Previous Occupational Radiation Exposure History**

TO BE COMPLETED BY PROJECT DIRECTOR

Project Director (Please Print): _____ **Signature:** _____

Authorization Number: _____ **Date:** _____

I have received instruction about prenatal exposure risks to the developing embryo/fetus and understand that because of these risks, the NRC regulations require that prenatal occupational exposure be 0.5 rem or less during the entire period of gestation to the declared pregnant woman. I have also been given an opportunity to ask questions and am aware that I may discuss prenatal occupational exposure with a member of the Radiological and Environmental Management staff at any time in the future.

I have read and understand the Purdue University Radiation Safety Handbook and am willing to abide by the university, state and federal regulations governing the use of radioisotopes and other sources of ionizing radiation.

I hereby grant permission to make available any and all information concerning my radiation exposure history while I was employed or assigned at the previously listed address(es).

I certify that the statements contained in this application are correct and complete to the best of my knowledge and belief.

Applicant's Signature: _____ **Date:** _____

APPENDIX A5: Form F-1 (Notice of Dosimetry Exposure)

REM - FORM F-1
Revised 8/06

PURDUE UNIVERSITY

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

Notice of Dosimetry Exposure

To: ,
From: ,
Date:

The badge number, _____ monitoring wear dates from _____ to _____ that was assigned to you reported the following exposures (in mrem):

	Whole Body Deep* Annual Limit = 5000 mrem	**Lens of Eye** Annual Limit = 15000 mrem	**Extremity/Skin** Annual Limit = 50000 mrem	**Fetal**** Gestation Limit = 500 mrem
For Monitoring Period				
Year-To-Date				
Cumulative % of Annual Limit				

It is our policy to notify individuals whose badges show doses greater than or equal to 100 mrem in a wear period. We have found that in many cases, such exposures can be avoided through changes in laboratory techniques. Occasionally, the exposure is due to a badge being inadvertently stored near a source and does not represent actual exposure to the person.

To assure Radiological & Environmental Management (REM) that you are aware of this radiation exposure and are attempting to minimize future exposures, please complete this form and return it to REM in the CIVL building immediately.

If you have any questions relative to your radiation exposure records, please feel free to call me at 49-42350.

1. REASON FOR THE EXPOSURE IN QUESTION (Check One):

   ☐ Normal work with radioactive materials or radiation-producing devices
   ☐ Cause of dose is unknown. (Did not work with radioactive materials or radiation-producing devices during period specified).
   ☐ Dose is a result of accidental exposure of badge only and does not represent personal dose. *(NOTE: If you checked this item, please attach a memo, signed by your department head, documenting the circumstances of the badge exposure. It will then be possible to remove the recorded dose from your exposure history records).*

2. If you checked the first box in item 1 above, what steps can you reasonably take to eliminate or minimize such future exposures in your radiation work?

Signature: _____ **Date:** _____

TO BE COMPLETED BY PROJECT DIRECTOR

Project Director (Please Print): _____ **Signature:** _____

Authorization Number: _____ **Date:** _____

* Any neutron exposure is computed into Whole Body dose, if applicable.
** Reported fetal exposure is for the gestation period (up to 9 months) after pregnancy has been declared in writing to the Radiation Safety Officer.
BDL = Below Detectable Limit
N/A = Not Applicable

APPENDIX A6: Form R-1 (Radioactive Material Requisition)

Purdue University REM Form R-1	RADIOACTIVE MATERIAL REQUISITION *Completed forms must be approved by Sharon Rudolph, REM, CIVL*			
Fund/Cost Center/GL Account/SID	**Name of Principal User**		**Authorization Number**	**Phone**
Quantity (mCi)	**Catalog Number**	**Nuclide and Form**		**Estimated Price**
				$
Vendor Suggested		**Date(s) Desired**		
Requested by		**Date of Request**	**Building**	**Room**
Approved by			**Date**	
Remarks			**Ship Date**	**Price**
				$

DO NOT WRITE IN SPACES BELOW (REM USE ONLY)

Approved for REM	**Date**	**Reference Number**
Purchase Order Number	**Received by & Date**	**Dispensed by & Date**

Health Physics Assay Information/ Survey

Quantity (mCi):	**Exposure Rate** (mR/hr) – **Unshielded:**		**Comments**
Concentration (mCi/mL):			
Volume (mL):	**Exposure Rate** (mR/hr) - **Shielded:**		
Specific Activity:			
Time of Assay:	**Other Precautions:**		
Purity:			
Lot Number:			
Other:	**Refrigerator**	☐	
Serial Number (Sealed Source):	**Freezer**	☐	
Notified (Date/Time):	**Shelf**	☐	
Left Message (Date/Time):			
Received by:		**Date:**	

APPENDIX A7: Form SM-1 (Survey Meter Inventory)

PURDUE UNIVERSITY

REM FORM SM-1
Revised 4/06

RADIOLOGICAL & ENVIRONMENTAL MANAGEMENT

Survey Meter Inventory

Manufacturer	Model	Serial Number	Purdue Number

Detector Type:

- ☐ End Window GM
- ☐ Side Window GM
- ☐ Pancake GM
- ☐ NaI Crystal
- ☐ Ion Chamber
- ☐ Other: _____

Scales:

CPM: _____ _____ _____ _____

mR/hr: _____ _____ _____ _____

"Owner" - Project Manager: _____

Other radionuclide project directors who share meter: _____

_____

_____

Storage Location: _____
Building Room

Area in Room: _____

This meter is to be used for:

- ☐ Detection of contamination
- ☐ Determination of exposure rate

Submitted by: _____ **Date:** _____

APPENDIX A8: NRC Form 3 (Notice to Employees)

NRC FORM 3
(5-2005)
Part 1

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, DC 20555-0001

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS (PART 19); EMPLOYEE PROTECTION

WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities, including power plants, are constructed to high quality standards and operated in a safe and secure manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should obey them. If you observe violations of the requirements or have a safety concern, you should report them.

WHAT IF I CAUSE A VIOLATION?

If you engaged in deliberate misconduct that may cause a violation of the NRC requirements, or would have caused a violation if it had not been detected, or deliberately provided inaccurate or incomplete information to either the NRC or to your employer, you may be subject to enforcement action. If you report such a violation, the NRC will consider the circumstances surrounding your reporting in determining the appropriate enforcement action, if any.

HOW DO I REPORT VIOLATIONS AND SAFETY CONCERNS?

If you believe that violations of NRC rules or the terms of the license have occurred, or if you have a safety concern, you should report them immediately to your supervisor. You may report violations or safety concerns directly to the NRC. However, the NRC encourages you to raise your concerns with the licensee since it is the licensee who has the primary responsibility for, and is most able to ensure, safe operation of nuclear facilities. If you choose to report your concern directly to the NRC, you may report this to an NRC inspector or call or write to the NRC Regional Office serving your area. If you send your concern in writing, it will assist the NRC in protecting your identity if you clearly state in the beginning of your letter that you have a safety concern or that you are submitting an allegation. The NRC's toll-free SAFETY HOTLINE for reporting safety concerns is listed below. The addresses for the NRC Regional Offices and the toll-free telephone numbers are also listed below. You can also e-mail safety concerns to allegation@nrc.gov.

WHAT IF I WORK WITH RADIOACTIVE MATERIAL OR IN THE VICINITY OF A RADIOACTIVE SOURCE?

If you work with radioactive materials or near a radiation source, the amount of radiation exposure that you are permitted to receive may be limited by NRC regulations. The limits on exposure for workers at NRC licensed facilities whose duties involve exposure to radiation are contained in sections 20.1201, 20.1207, and 20.1208 of Title 10 of the Code of Federal Regulations (10 CFR 20) depending on the part of the regulations to which your employer is subject. While these are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as is "reasonably achievable."

MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to advise you of your dose annually if you are exposed to radiation for which monitoring was required by NRC. In addition, you may request a written report of your exposure when you leave your job.

HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

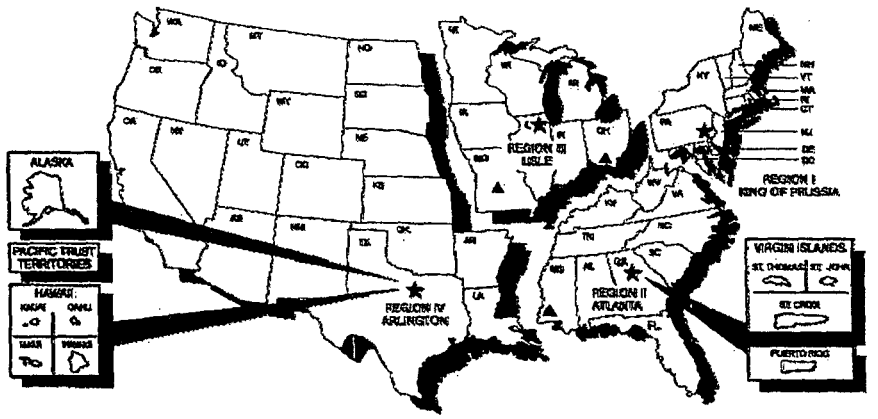
NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors may conduct their own inspections to assure compliance. All inspectors are protected by Federal law. Interference with them may result in criminal prosecution for a Federal offense.

MAY I TALK WITH AN NRC INSPECTOR?

Yes. NRC inspectors want to talk to you if you are worried about radiation safety or have other safety concerns about licensed activities, such as the quality of construction or operations at your facility. Your employer may not prevent you from talking with an inspector. The NRC will make all reasonable efforts to protect your identity where appropriate and possible.

MAY I REQUEST AN INSPECTION?

Yes. If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection. Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.



▲ - Callaway Plant Site in Missouri and Grand Gulf Plant Site in Mississippi are under the purview of Region IV. The Portsmouth Gaseous Diffusion Plant in Ohio is under the purview of Region II.

NRC FORM 3
5-2005)
Part 2

HOW DO I CONTACT THE NRC?

Talk to an NRC inspector on-site or call or write to the nearest NRC Regional Office in your geographical area (see map below). If you call the NRC's toll-free SAFETY HOTLINE during normal business hours, your call will automatically be directed to the NRC Regional Office for your geographical area. If you call after normal business hours, your call will be directed to the NRC's Headquarters Operations Center, which is manned 24 hours a day. You can also e-mail safety concerns to allegation@nrc.gov.

CAN I BE FIRED FOR RAISING A SAFETY CONCERN?

Federal law prohibits an employer from firing or otherwise discriminating against you for bringing safety concerns to the attention of your employer or the NRC. You may not be fired or discriminated against because you engage in certain protected activities, including but not limited to,

- ask the NRC to enforce its rules against your employer;
- refuse to engage in activities which violate NRC requirements;
- provide information or are about to provide information to the NRC or your employer about violations of requirements or safety concerns;
- are about to ask for, or testify, help, or take part in an NRC, Congressional, or any Federal or State proceeding.

WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

It is unlawful for an employer to fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC or raise a safety issue or otherwise engage in protected activities. Violations of Section 211 of the Energy Reorganization Act (ERA) of 1974 (42 U.S.C. 5851) include actions such as harassment, blacklisting, and intimidation by employers of (i) employees who bring safety concerns directly to their employers or to the NRC; (ii) employees who have refused to engage in an unlawful practice, provided that the employee has identified the illegality to the employer; (iii) employees who have testified or are about to testify before Congress or in any Federal or State proceeding regarding any provision (or proposed provision) of the ERA or the Atomic Energy Act (AEA) of 1954; (iv) employees who have commenced or caused to be commenced a proceeding for the administration or enforcement of any requirement imposed under the ERA or AEA or who have, or are about to, testify, assist, or participate in such a proceeding.

HOW DO I FILE A DISCRIMINATION COMPLAINT?

If you believe that you have been discriminated against for bringing violations or safety concerns to the NRC or your employer, you may file a complaint with the NRC, the U.S. Department of Labor (DOL), or appropriate state entities. If you desire a personal remedy, you must file a complaint with the DOL pursuant to Section 211 of the ERA or with appropriate state entities. Your complaint to the DOL must describe in detail the basis for your belief that the employer discriminated against you on the basis of your protected activity, and it must be filed in writing either in person or by mail within 180 days of the discriminatory occurrence. Additional information is available at the DOL web site at www.osha.gov. Filing an allegation, complaint, or request for action with the NRC does not extend the requirement to file a complaint with the DOL within 180 days. To do so, you may contact the Allegation Coordinator in the appropriate NRC Region, as listed below, who will provide you with the address and telephone number of the correct OSHA Regional office to receive your complaint. You may also check your local telephone directory under the U.S. Government listings for the address and telephone number of the appropriate OSHA Regional office.

WHAT CAN THE DEPARTMENT OF LABOR DO?

If your complaint involves a violation of Section 211 of the ERA by your employer, it is the DOL, NOT THE NRC, that provides the process for obtaining a personal remedy. The DOL will notify your employer that a complaint has been filed and will investigate your complaint.

If the DOL finds that your employer has unlawfully discriminated against you, it may order that you be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination and be paid attorney's fees and costs.

Relief will not be awarded to employees who engage in deliberate violations of the Energy Reorganization Act or the Atomic Energy Act.

WHAT WILL THE NRC DO?

The NRC will evaluate each allegation of harassment, intimidation, or discrimination to determine whether sufficient information exists to initiate an investigation. Following this evaluation, an investigator from the NRC's Office of Investigations may interview you and review available documentation. Based on the evaluation, and, if applicable, the interview, the NRC will assign a priority and a decision will be made whether to pursue the matter further through an investigation. The assigned priority is based on the specifics of the case. The NRC may not pursue an investigation of low priority cases to the point that a conclusion can be made whether the harassment, intimidation, or discrimination actually occurred. If you do not object, the NRC may refer lower priority cases to the involved licensee for a response and will request that the licensee independently review such issues. Even if NRC decides not to pursue an investigation, if you have filed a complaint with the DOL, the NRC will monitor the results of the DOL investigation.

If the NRC or the DOL finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted by employees who wish to register complaints or concerns about radiological working conditions or other matters regarding compliance with Commission rules and regulations at the following addresses and telephone numbers.

REGIONAL OFFICES

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission, Region I 475 Allendale Road King of Prussia, PA 19406-1415	(800) 432-1156
II	U.S. Nuclear Regulatory Commission, Region II Sam Nunn Atlanta Federal Center 61 Forsyth Street, S.W., Suite 23T85 Atlanta, GA 30303-8931	(800) 577-8510
III	U.S. Nuclear Regulatory Commission, Region III 2443 Warrenville Road, Suite 210 Lisle, IL 60532-4352	(800) 522-3025
IV	U.S. Nuclear Regulatory Commission, Region IV 611 Ryan Plaza Drive, Suite 400 Arlington, TX 76011-4005	(800) 952-9677

To report safety concerns or violations of NRC requirements by your employer,

telephone:

NRC SAFETY HOTLINE

1-800-695-7403

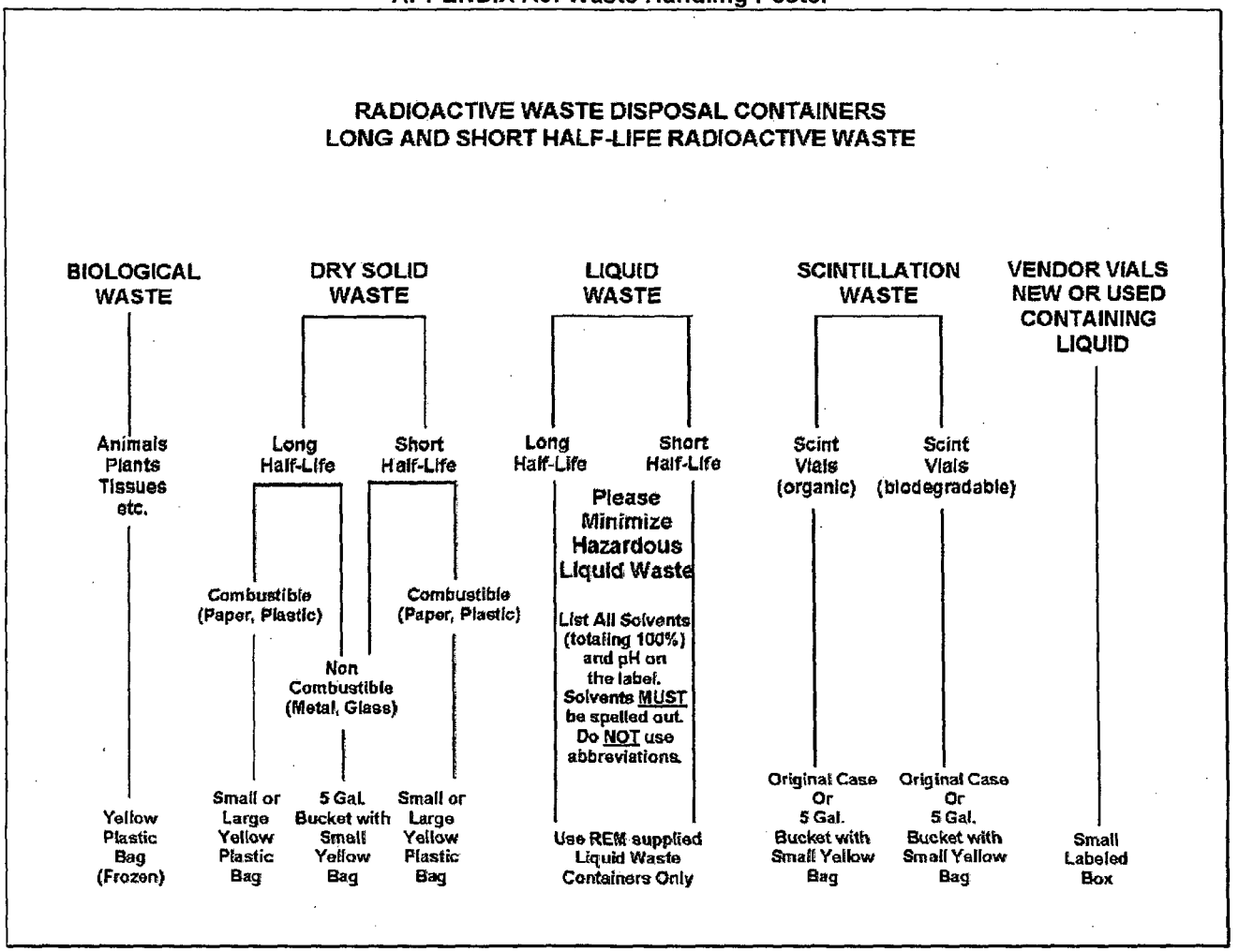
To report incidents involving fraud, waste, or abuse by an NRC employee or NRC contractor,

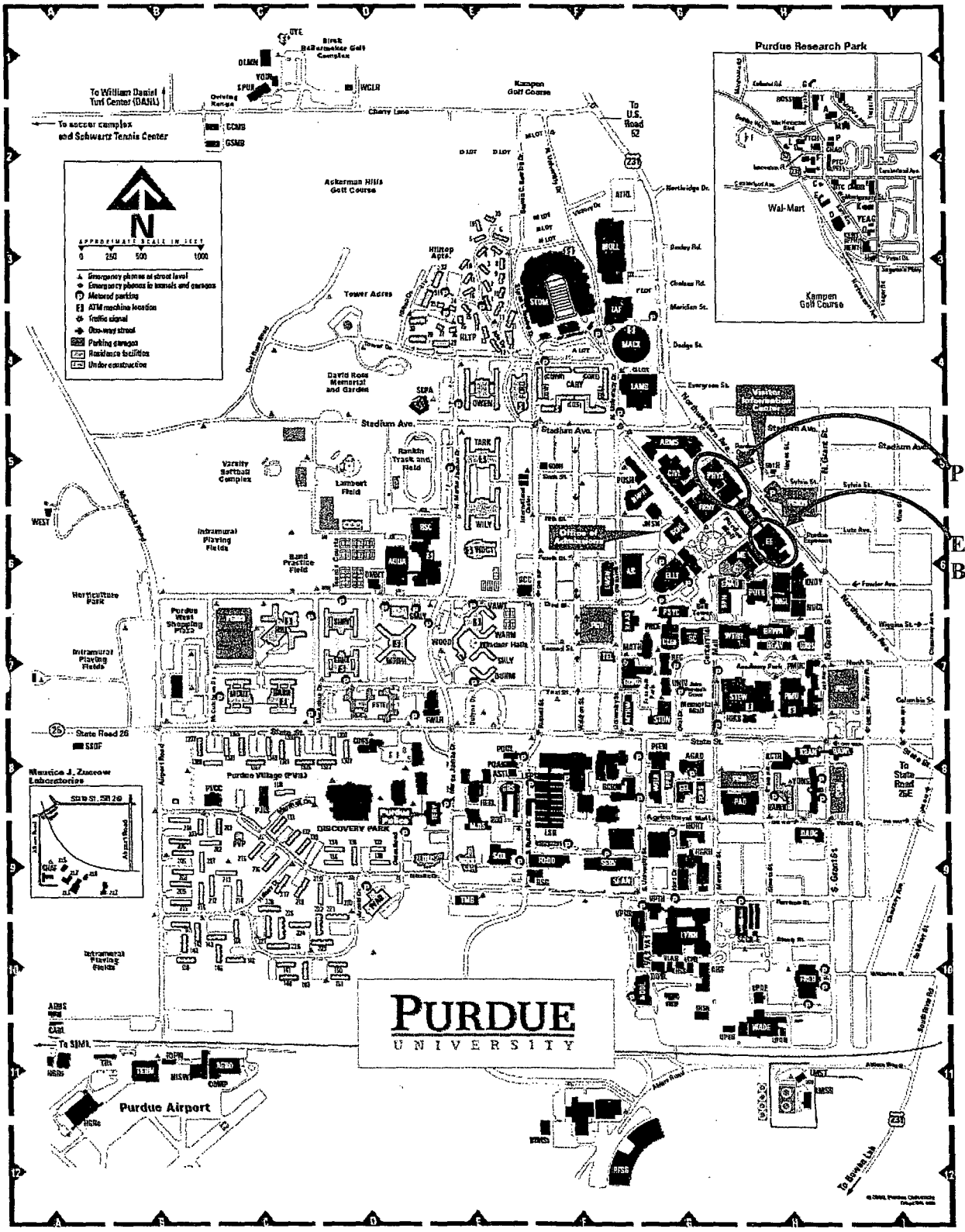
telephone:

OFFICE OF THE INSPECTOR GENERAL HOTLINE

1-800-233-3497

APPENDIX A9: Waste Handling Poster





Physics Building

Electrical Eng. Building

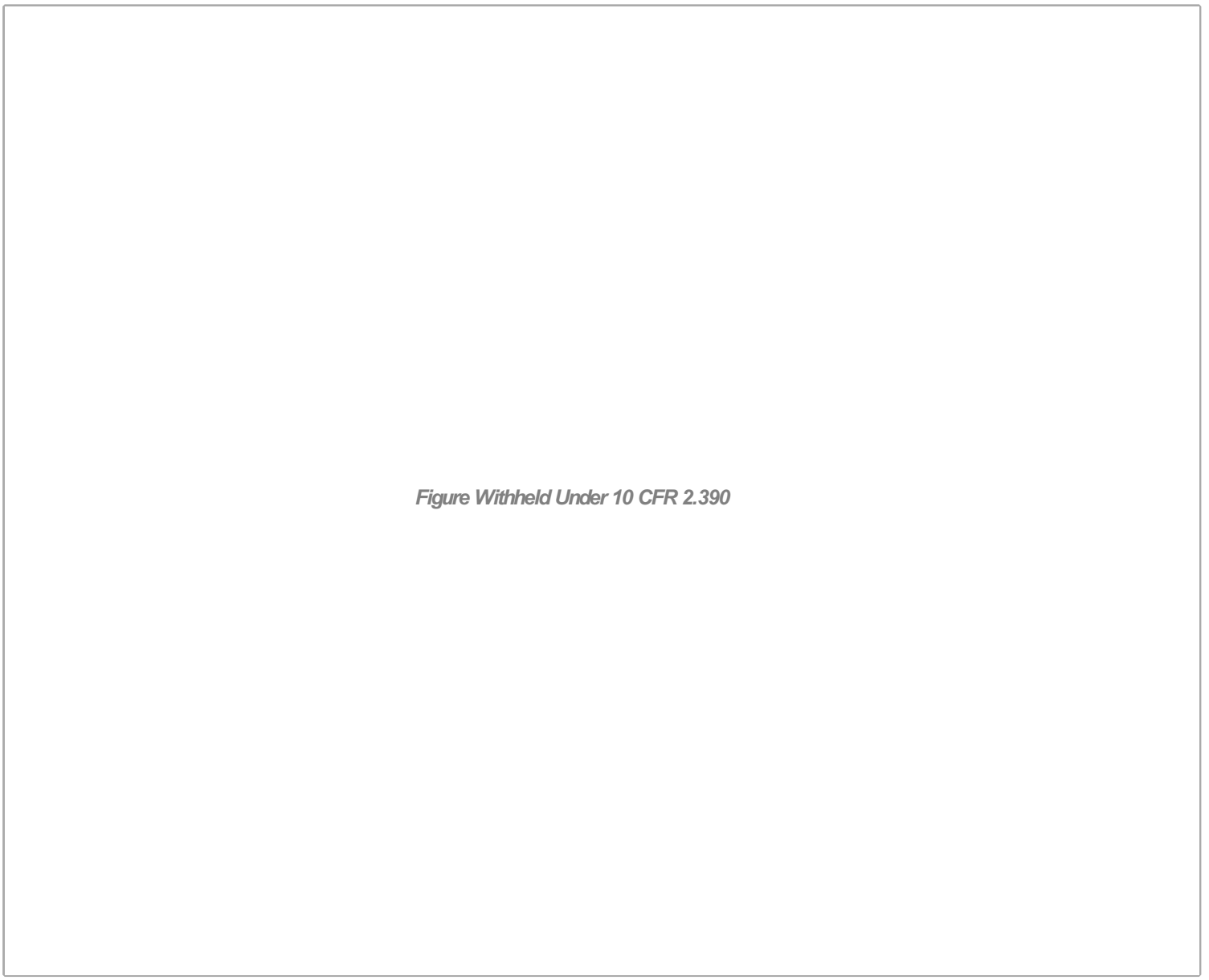


Figure Withheld Under 10 CFR 2.390


Figure Withheld Under 10 CFR 2.390

Schematic of Cabinets for 1.3% Fuel

Details of Cabinet for 1.3% Fuel

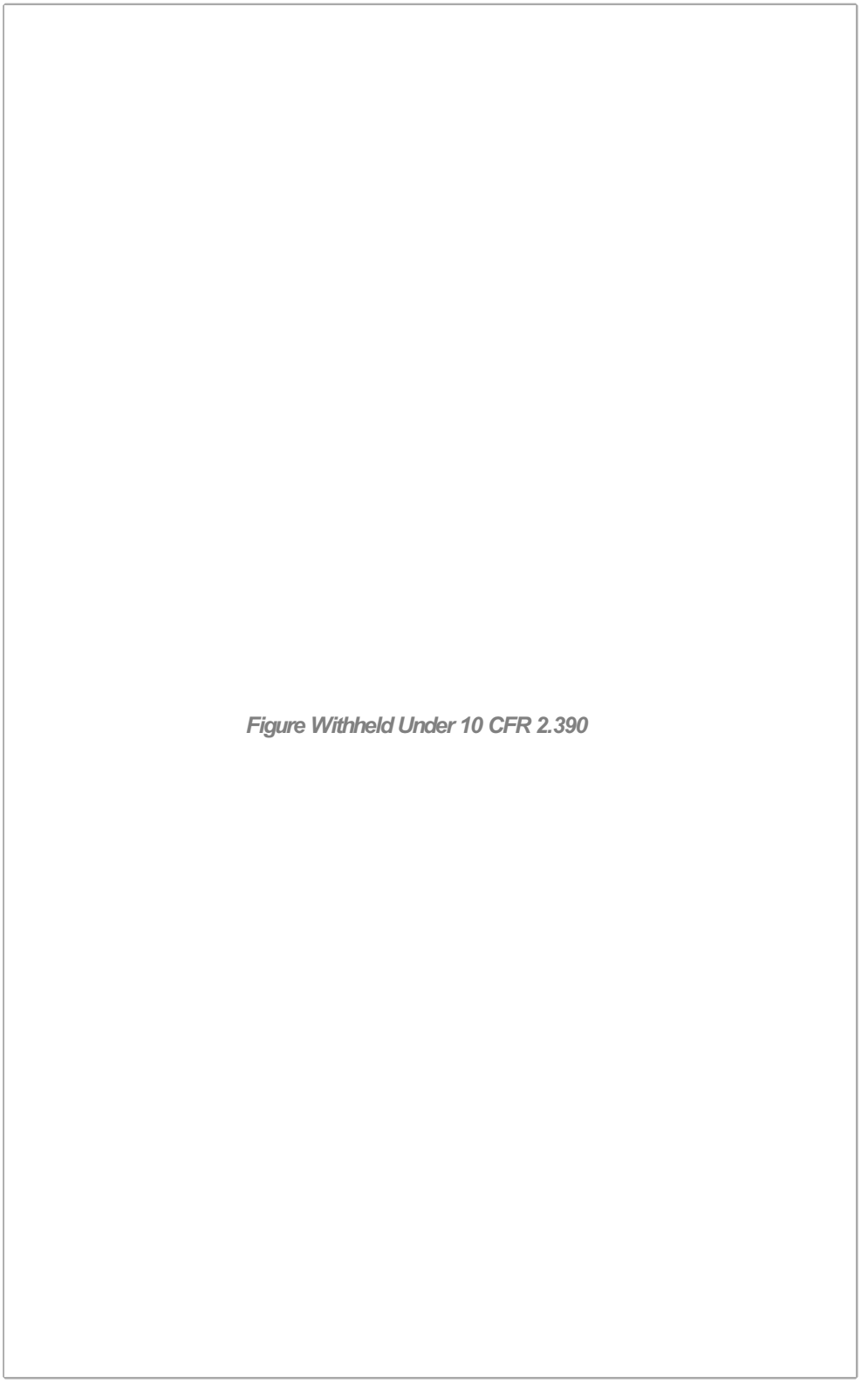
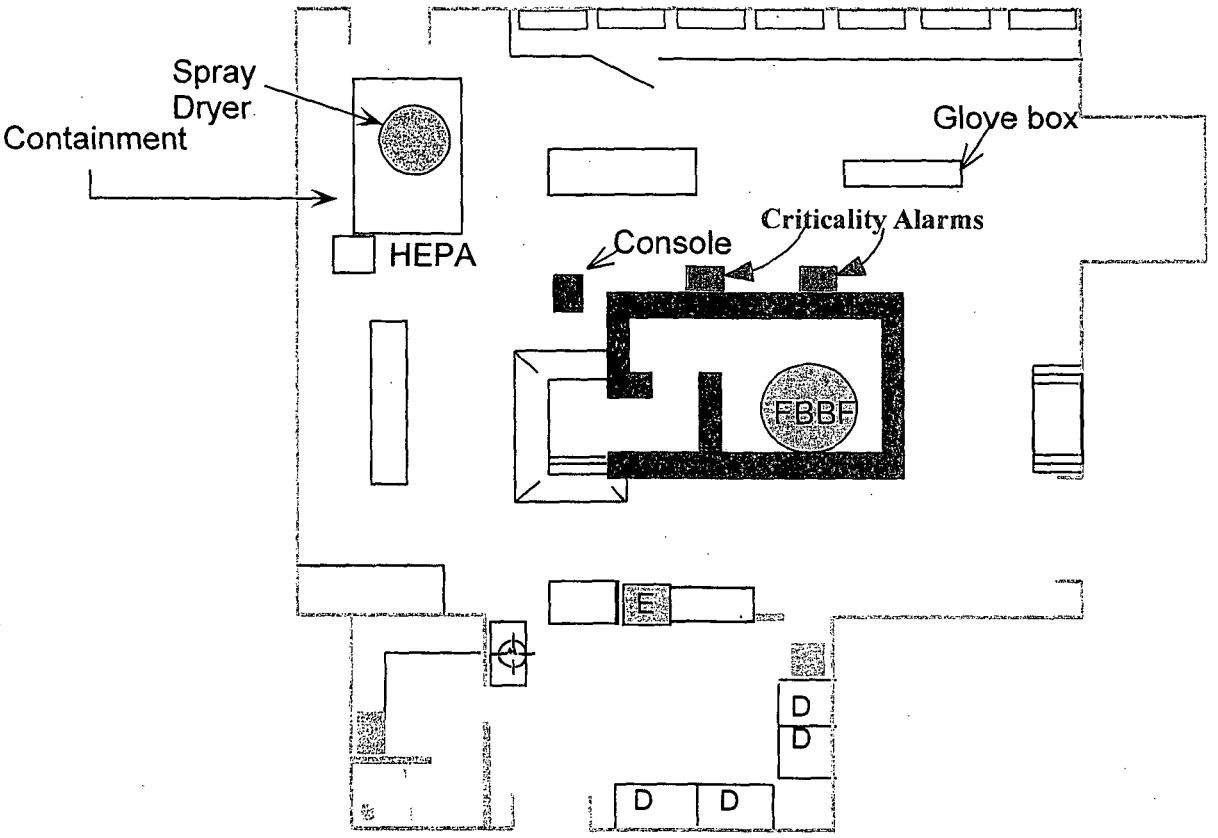
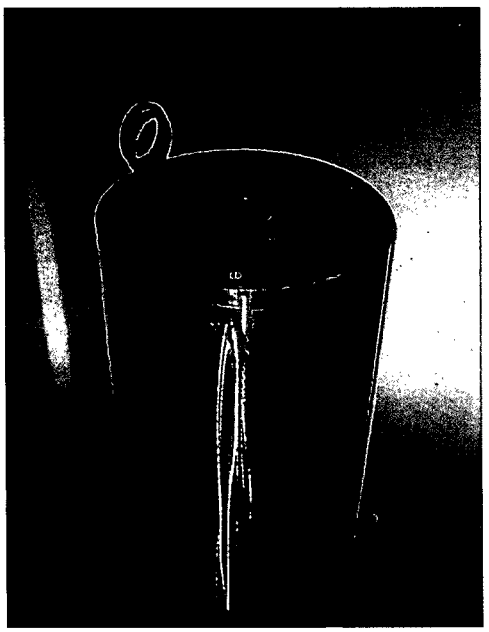
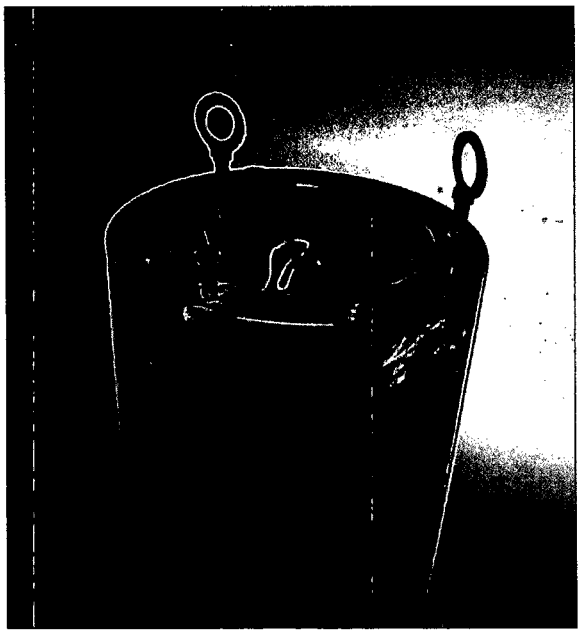
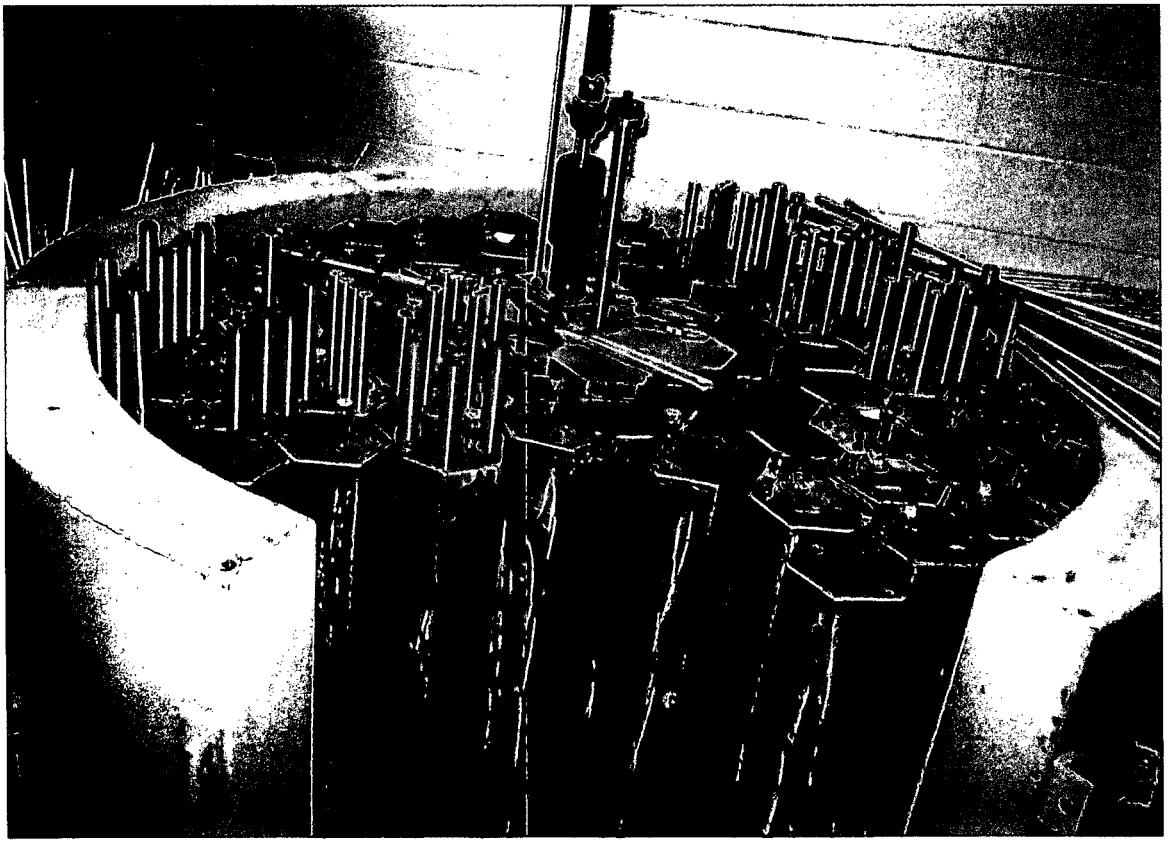


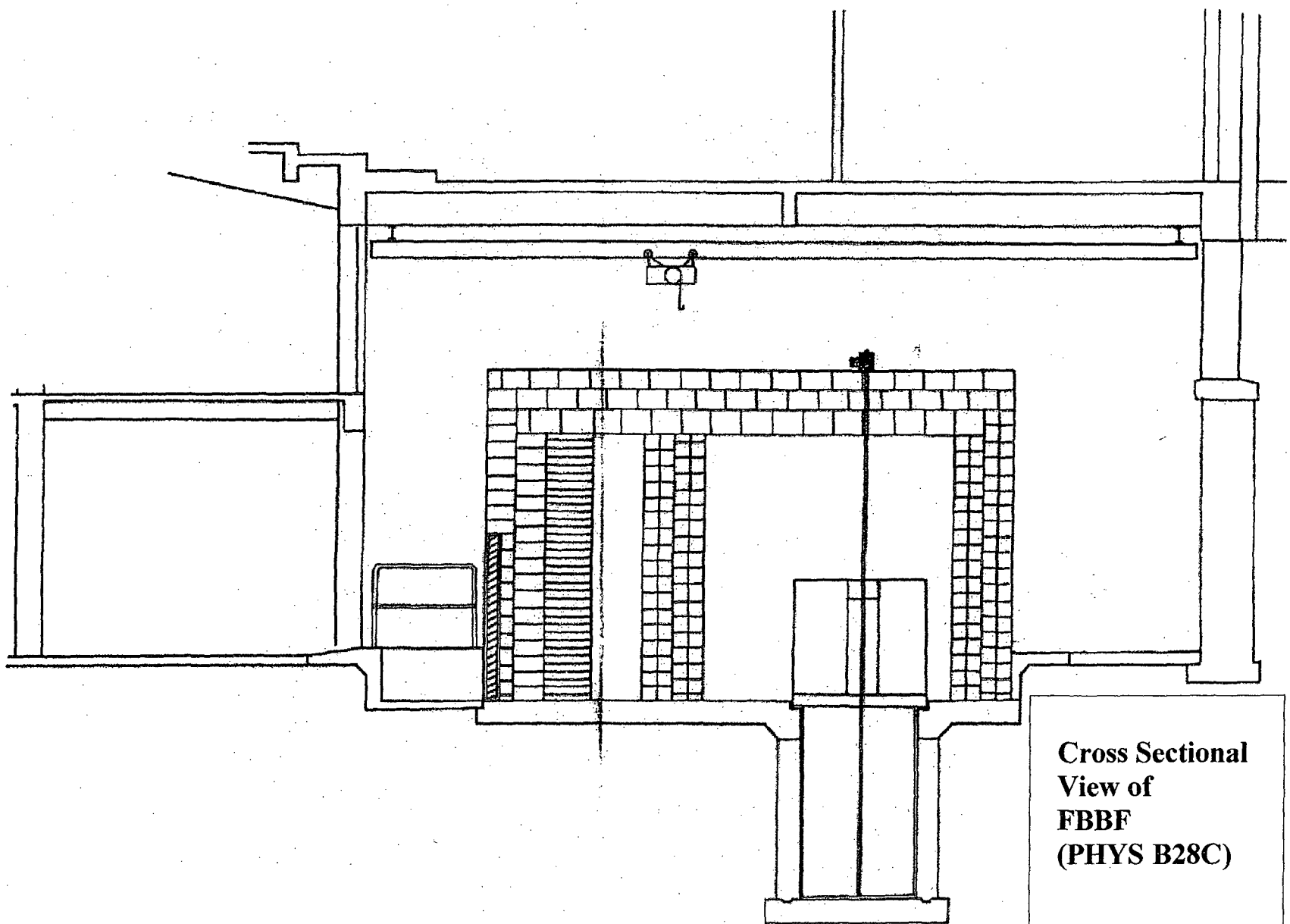
Figure Withheld Under 10 CFR 2.390


Spray
Dryer
Containment
HEPA
Glove box
Criticality Alarms
Console
FBBF
E
D
D
D
D









Cross Sectional View of FBBF (PHYS B28C)

Surface contamination surveys are conducted at the FBBF facility every calendar month to determine levels of removable contamination. Smears are taken of 100 cm^2 areas. Acceptable surface contamination levels are shown in the following table:

Nuclide[a]	*Average*[bc]	*Maximum*[bd]	*Removable*[b]
U-Natural	5,000 dpm α / 100 cm^2	15,000 dpm α / 100 cm^2	1,000 dpm α / 100 cm^2
U-235	5,000 dpm α / 100 cm^2	15,000 dpm α / 100 cm^2	1,000 dpm α / 100 cm^2
Transuranics	100 dpm α / 100 cm^2	300 dpm α / 100 cm^2	20 dpm α / 100 cm^2

a. Where surface contamination by both alpha- and beta-emitting nuclides exists, the limits established for alpha and beta-gamma-emitting nuclides apply independently.
b. As used in this table, dpm (disintegrations per minute) means the rate of emission 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 contaminant are not 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 or not more than 200 cm^2.