PPPL RADIATION PROTECTION PROGRAM (RPP)

SUBPART A GENERAL PROVISIONS

10.1 SCOPE AND POLICY

The provisions of this program apply to all PPPL activities that manage radiation and radioactive materials that may potentially result in radiation exposure to workers, the public and/or the environment. Included are the testing and operation of nuclear fusion devices and related experiments and the Shutdown and Removal of the Tokamak Fusion Test Reactor (TFTR). In those cases where contractors or subcontractors are employed to conduct PPPL funded radiological activities at non-PPPL sites or facilities, and such organizations do not possess a U.S. Nuclear Regulatory Commission (NRC) or Agreement State license for the proposed activity, the application of the provisions of this program is required.

Essential elements of the PPPL Radiation Protection Program include:

- Senior Management Commitment to assure a high quality, effective radiological control program through the dedication of adequate resources for that purpose,
- Line managers committed to minimizing radiation exposure and controlling radioactivity;
- The use of only trained, qualified personnel to perform tasks that involve radiation and/or radioactive materials;
- A professional Health Physics organization to manage the PPPL radiological control function;
- A facility-wide commitment to the ALARA policy; and
- The use of both internal and external audits to assess the adequacy and effectiveness of the program.

It is the policy of PPPL that no employee or contractor of PPPL shall take or cause to be taken any action that is inconsistent with the requirements of this Radiation Protection Program. PPPL management at all levels shall be responsible for PPPL compliance with this program. Nothing in this RPP shall be construed as limiting actions necessary to protect health and safety.

10.2 DEFINITIONS

The following definitions apply to the PPPL RPP and are used in the Program Manual:

Airborne Radioactive Material or **Airborne Radioactivity -** Radioactive material in any chemical or physical form that is dissolved, mixed, suspended, or otherwise entrained in air.

Airborne Radioactivity Area - any area where the measured concentration of airborne radioactivity, above

natural background, exceeds or is likely to exceed 10 percent of the derived air concentration (DAC) values listed in appendix A or appendix C.

ALARA - "As Low As is Reasonably Achievable," is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical and public policy considerations. ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits as is reasonably achievable.

Ambient Air -The general air in the area of interest (e.g., the general room atmosphere), as distinct from a specific
stream or volume of air that may have different properties.

Annual Limit on Intake (ALI) - The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rem or a committed dose equivalent of 50 rem to any individual organ or tissue.

Background - radiation from:

A. Naturally occurring radioactive materials which have not been technologically enhanced;

B. Cosmic sources;

C. Global fallout as it exists in the environment;

D. Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities;

E. Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.

Bioassay - the determination of kinds, quantities, or concentrations, and in some cases locations of radioactive material in the human body, whether by direct measurement or by analysis, and the evaluation of radioactive materials excreted or removed from the human body.

Calibration - Process of adjusting and/or determining either:

A. The response or reading of an instrument relative to a standard (e.g., primary, secondary or tertiary) or to a series of conventionally true values; or

B. The strength of a radiation source relative to a standard or conventionally true value.

Contamination - The disposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

Contamination Area - Any area where contamination levels are greater than the values specified in appendix D, but less than or equal to 100 times those levels.

Continuous Air Monitor (CAM) - An instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels.

Controlled Area - Any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive material. Individuals who enter only a controlled area without entering radiological areas are not expected to receive a total effective dose equivalent of more than 100 mrem in a year.

Declared Pregnant Worker - A woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus as provided in this manual. This declaration may be revoked, in writing, at any time by the declared pregnant worker.

Derived Air Concentration (DAC) - The airborne concentration for the radionuclides listed in appendix A that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 ml).

Direct Ionizing Particles - Any electrically charged particles (electrons, protons, alpha particles, muons, etc.) having sufficient energy to produce ionization by collision.

Dosimeter - A portable instrument for measuring and registering the total accumulated exposure to ionizing radiation.

Enclosed Beam X-ray System - One in which all possible X-ray paths are fully enclosed and dose rates at any accessible surface are less than 0.5 mR/hour.

Entrance or Access Point - Any location through which an individual could gain access to areas controlled for the purposes or radiation protection. This includes entry or exit portals of sufficient size to permit human entry irrespective of their intended use.

General Employee - An individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or a visitor who performs work for, or in conjunction with, DOE or utilizes DOE facilities.

High Contamination Area - Any area where contamination levels are greater than l00 times the values specified in appendix D.

High Radiation Area - Any area, accessible to individuals, where radiation levels could result in an individual receiving a deep dose equivalent in excess of 0. 1 rem in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Individual - Any human being.

Member of the Public - An individual who is not occupationally exposed to radiation or radioactive material.

Minor - An individual less than 18 years of age.

Monitoring - Actions intended to detect and quantify radiological conditions.

Nonstochastic Effects - Effects due to radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation induced opacities within the lens of the eye).

Occupational Exposure - An individual's exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational exposure does not include planned special exposures, exposure received as a medical patient, background radiation or voluntary participation in medical research programs.

Person - Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency, any State or political subdivision of, or any political entity within a State, any foreign government or nation or other entity, and any legal successor, representative, agent or agency of the foregoing; provided that person does not include the DOE or the U.S. Nuclear Regulatory Commission.

Radiation - Ionizing radiation: alpha particles, beta particles, gamma rays, X-rays, neutrons, high speed electrons, high speed protons, and other particles capable of producing ions. Radiation as used herein, does not include nonionizing radiation, such as radio- or micro-waves, or visible, infrared, or ultraviolet light.

Radiation Area - Any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

Radiologically Controlled Area - Any area where an individual may receive greater than 100 mrem in any calendar year or an area posted as a "radioactive materials area," a "radiation area," "high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area."

Radiological Worker - A general employee whose job assignment involves operation of or work with radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0. 1 rem per year total effective dose equivalent.

Representative (as applied to the sampling of radioactive material) - Sampling in such a manner that the sample closely approximates both the amount of activity and the physical and chemical properties of the material.

Stochastic Effects - Malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold for radiation protection purposes.

Survey - An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal or presence of radioactive material or other sources of radiation.

Very High Radiation Area - Any area accessible to individuals where radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads in one hour at I meter from a radiation source or from any surface that the radiation penetrates.

Year - The period of time beginning on or near January 1 used to determine compliance with the provisions of 10 CFR 835. The starting date of the year used to determine compliance may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

10.3 UNITS OF RADIATION DOSE

The units of measurement used herein to describe various aspects of radiation dose are as follows:

Absorbed Dose (D) - The energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (I rad = 0.01 gray)

Collective Dose - The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

Committed Dose Equivalent ($H_{T,50}$) - The dose equivalent calculated to be received by a tissue or organ over a 50 year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external **to** the body. Committed dose equivalent is expressed in units of rem (or sievert).

Committed Effective Dose Equivalent ($H_{E,50}$) - The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor (w_T). Committed effective dose equivalent is expressed in units of rem (or sievert).

Cumulative Total Effective Dose Equivalent - The sum of the effective dose equivalents recorded for an individual for each year of employment at a DOE or DOE contractor site or facility, effective January 1, 1989.

Deep Dose Equivalent - The dose equivalent derived from external radiation at a depth of 1 cm in tissue.

Dose Equivalent (H) - The product of absorbed dose (D) in rad in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.0 I sievert) -

Effective Dose Equivalent (H_E) - The summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factor (W_T). It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert).

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

Extremity - Hands and arms below the elbow or feet and legs below the knee.

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

Lens of the Eye Dose Equivalent - The external exposure of the lens of the eye. This is taken as the dose equivalent at a tissue depth of 0.3 cm.

Quality Factor (Q) - The principal modifying factor used to calculate the dose equivalent from the absorbed dose. The absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor. The quality factors to be used for determining dose equivalent in rem are listed in Table 1 0. 1. When spectral data are insufficient to identify the energy of the neutrons, a quality factor of 10 shall be used. The quality factor that is used for 2.5 MeV neutrons is 9; for 14 MeV neutrons is 7.5. For other neutron energies when the spectral data is sufficient the following table should be consulted.

Table 10.1

Radiation Type	Quality Factor
X-rays, gamma rays, positrons, electrons (including tritium beta particles	1
Neutrons, ≤ 10 keV	3
Neutrons, > 10 keV	10
Protons and singly-charged particles of unknown energy with rest mass greater than one atomic mass unit	10
Alpha particles and multiple-charged particles (and particles of unknown charge) of unknown energy	20

Shallow Dose Equivalent-The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

Total Effective Dose Equivalent (TEDE) - The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). For purposes of compliance with 10 CFR 835, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.

Weighting factor (w_T) - The fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to tissue, T, is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue. The weighting factors are as follows:

Table 10.2

WEIGHTING FACTORS FOR VARIOUS TISSUES

Organs or Tissues, T	**Weighting Factor, w_T**
Gonads	0.25
Breasts	0.15
Red Bone Marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder 1	0.30
Whole Body 2	1.00

1. "Remainder" means the five other organs or tissues with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, and upper large intestine). The weighting factor for each remaining organ or tissue is 0.06.

2. For the case of uniform external irradiation of the whole body, a weighting factor (w_T) equal to I may be used in determination of the effective dose equivalent.

Whole Body - For the purposes of external exposure, whole body is the head, trunk (including male gonads), arms above and including the elbows, or legs above and including the knee.

10.4 RADIOLOGICAL UNITS

The quantities used in the records required by 10 CFR 835 shall be clearly indicated in units of Curie, rad, or rem including multiples and subdivisions of these units.

SUBPART B RADIATION PROTECTION PROGRAMS

10.101.1 PROGRAM PARAMETERS

Changes in the PPPL operational program, as described in the scope of this document, that will increase the risk of exposure to radiation or change the nature of that risk, require change to this RPP and subsequent approval by the DOE prior to implementation. Both this RPP or an update shall be considered approved 180 days after submission unless rejected by the DOE at an earlier date.

Changes that do not decrease the effectiveness of the approved RPP may be implemented immediately but must be submitted to the DOE for approval within 180 days of implementation.

An update of this RPP shall be submitted to the DOE within 180 days of the effective date of any modification to 10 CFR 835. This RPP may be modified by the DOE.

Compliance with the provisions of this RPP shall be accomplished through adherence to policies detailed herein and through verbatim compliance with operational and radiation safety procedures developed to assure the performance of tasks under the provisions of 10 CFR 835.

10.101.2 THE PPPL ALARA PROGRAM

The concept of maintaining radiation exposures not only within statutory limits but also as low as is reasonably achievable (ALARA) is implemented at PPPL by the operation of a formal ALARA program. This program is described in detail in the PPPL ALARA Plan. Major elements of the plan include the following:

- Senior Management Oversight - The PPPL Director ensures that the authority, commitment and resources are provided to adequately implement the ALARA program. He reviews the results of the program and approves exposure goals based on operational requirements. As senior executive, he appoints an ALARA Review Committee to oversee the effectiveness of the program.

- Middle Management and Supervisory Implementation - Managers and Supervisors implementations the ALARA program, including working to achieve the assigned ALARA goals.

- An ALARA Organization - The ALARA Organization consists of an ALARA committee chaired by the Manager of the Health Physics Division, an ALARA Coordinator who provides technical support and assistance for the implementation of the program, and members of the Health Physics Division which conducts radiological surveillances, establishes exposure controls and prescribes protective requirements for radiological work.

- ALARA Training - Appropriate training is given to all radiation workers to instill an awareness and appreciation of the ALARA concept. Training includes information on the biological effects of radiation, instruction in the relation of time, distance and shielding to radiation protection, and the effects of ventilation, filtration and containment on the spread of

and exposure to radioactive contaminants.

- PPPL Radiation Workers - Workers at PPPL are an essential element in the ALARA program. After thorough training in the relationship between radiation exposure and work methods, they maintain dose to as low as reasonably achievable by strict adherence to approved procedures and compliance with PPPL radiological control requirements.

- Task Preplanning - Individual tasks, both operational and support, that involve radiation and/ or radioactive contamination are pre-planned to avoid unnecessary exposure, reviewed by both management ALARA personnel and approved through the issuance of a Radiation Work Permit.

- Procedural Controls - Controls are introduced into operational procedures that are designed to reduce personnel exposure to ALARA levels.

- ALARA Design Criteria - Construction and modification of facilities and equipment that involve radiation or radioactive contamination conform to ALARA influenced design criteria.

- Lessons Learned Policy - Major tasks that involve radiation or radioactive contamination are critiqued to take advantage of lessons learned so that future exposures can be reduced.

- Tracking and Trending - Both collective and average dose equivalents for similar work are tracked and trended to detect changes in exposure so that increases can be ameliorated and the reasons for decreases can be identified for future reference.

- Internal ALARA Audits - Internal audits of all functional elements of the ALARA program are conducted periodically and as required by the ES&H Executive Board or the ALARA Review Committee (ALARARC).

- Radiological Performance Goals -Radiological Performance Goals are established, approved, and reviewed periodically.

- Radiological Administrative Control Levels - Challenging administrative control levels are established, approved, and reviewed periodically.

- Optimization Methodology - Optimization methods are used to assure that occupational exposures are maintained ALARA when developing and justifying facility designs and physical controls.

- Records - Documents are maintained that demonstrate compliance with ALARA program implementation.

10.102 INTERNAL AUDITS

Internal audits of all functional elements of the radiation protection program are conducted no less frequently than every 3 years and include program content, performance, applicability, and implementation.

SUBPART C EXPOSURE LIMITS

10.201 (RESERVED)

10.202 OCCUPATIONAL EXPOSURE LIMITS FOR RADIATION WORKERS

The occupational exposure to general employees resulting from PPPL activities, other than "Planned Special Exposures " received under the provisions of paragraph 10.204 and emergency exposure situations received under the provisions of paragraph 10. 1302, are controlled so that the following annual limits are not exceeded:

- A total effective dose equivalent of 5 rem
- The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rem
- A lens of the eye dose equivalent of 15 rem
- A shallow dose equivalent of 50 rem to the skin or to any extremity

All occupational exposure received during the current year is included when demonstrating compliance with this paragraph.

Exposures from background, therapeutic and diagnostic medical radiation and voluntary participation in medical research programs shall not be included in dose records or in the assessment of compliance with the occupational exposure limits.

10.203 COMBINING INTERNAL AND EXTERNAL DOSE EQUIVALENTS

The total effective dose equivalent during a year is determined by summing the effective dose equivalent from external exposures and the committed effective dose equivalent from intakes during the year. For purposes of compliance with 10 CFR 835, deep dose equivalent to the whole body is used as effective dose equivalent for external exposures.

Determinations of the effective dose equivalent are made using the weighting factor values provided in Table 10.2.

For the case of uniform external irradiation of the whole body, a weighting factor (W_T) equal to 1 is used in the determination of the effective dose equivalent.

10.204 PLANNED SPECIAL EXPOSURES

A planned special exposure may be authorized for a radiological worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in paragraph 10.202, provided that each of the following conditions is satisfied:

- The planned special exposure is considered only in an exceptional situation when alternatives that might prevent a radiological worker from exceeding the limits in paragraph 10-202, above, are impractical or unavailable.
- PPPL management (and the employer, if the employer is not PPPL) specifically requests the planned exposure, in writing.
- Joint written approval from the appropriate DOE Headquarters program office and the Assistant Secretary for Environment, Safety and Health is received.
- The individual's dose from all previous planned special exposures and an doses in excess of the occupational dose limits is determined prior to requesting an individual to participate in an authorized planned special exposure.
- An individual shall not receive a planned special exposure that, in addition to the doses determined above, would result in a dose that exceeds a total effective dose equivalent of 5 rem in the current year and a cumulative total effective dose equivalent of 25 rem.
- Prior to a planned special exposure, written consent shall be obtained from each individual exposed and each individual shall be:

    a. Informed of the purpose of the planned operations and procedures to be used;

    b. Informed of the estimated doses and associated potential risks and specific radiological conditions and other hazards which might be involved in performing the task; and

    c. Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

- Records of the conduct of a planned special exposure shall be maintained and a written report shall be submitted within 30 days after the planned special exposure to the appropriate DOE Headquarters program office and to the Assistant Secretary for Environment, Safety, and Health.
- The dose from planned special exposures is not considered in controlling future occupational dose, but shall be included in records and reports required by 10 CFR 835.

10.205 NON-UNIFORM EXPOSURE OF THE SKIN

Non-uniform exposures of the skin from X-rays, beta radiation, and/or radioactive material on the skin shall be assessed as follows:

- If the area of the skin irradiated is 1.00 cm^2 or more, the non-uniform dose equivalent received during the year is averaged over the 100 cm^2 of skin receiving the maximum dose, added to any uniform dose equivalent also received by the skin, and recorded as the shallow dose equivalent to any extremity or skin for the year.

- If the area of skin irradiated is 10 cm^2 or more, but less than 100 cm^2, the non-uniform dose equivalent to the irradiated area received during the year is added to any uniform dose equivalent also received by the skin and recorded as the shallow dose equivalent to any extremity or skin for the year. The non-uniform dose equivalent is the dose equivalent averaged over the 1 cm^2 of skin receiving the maximum absorbed dose, reduced by the fraction which is the irradiated area in cm^2 divided by 1 00 cm^2. In no case is a value for the fraction of less than 0. 1 used.

- If the area of skin irradiated is less than 10 cm^2, the non-uniform dose equivalent is averaged over the 1 cm^2 of skin receiving the maximum dose. This dose equivalent is recorded in the individual's occupational exposure history as a special entry and is not added to any other shallow dose equivalent to any extremity or skin recorded as the dose equivalent for the year.

10.206 LIMITS FOR THE EMBRYO/FETUS

The dose equivalent limit for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem. Substantial variation above a uniform exposure rate that would satisfy this limit is avoided. If the dose equivalent to the embryo/fetus is determined to have already exceeded 0.5 rem by the time a worker declares her pregnancy, the declared pregnant worker is not assigned to tasks where additional occupational exposure is likely during the remaining gestation period.

10.207 LIMITS FOR MINORS

No minor may be exposed to radiation and/or radioactive material during direct on-site access at PPPL in excess of 0. 1 rem total effective dose equivalent in a year.

10.208 LIMITS FOR MEMBERS OF THE PUBLIC ENTERING A CONTROLLED AREA

No member of the public may be exposed to radiation and/or radioactive material during direct on- site access at PPPL in excess of 0. 1 rem total effective dose equivalent in a year.

10.209 CONCENTRATIONS OF RADIOACTIVE MATERIAL IN AIR

The derived air concentration (DAC) values given in appendices A and C are used in the control of occupational exposures to airborne radioactive material. Compliance with this paragraph with regard to inhalation exposures

and external exposures from airborne radionuclides shall be demonstrated through conformity with Sections 10.101 and 10.202 of this RPP.

The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are unavailable, inadequate, or internal dose estimates based on representative air concentration values have been demonstrated to be as or more accurate.

10.210 ADMINISTRATIVE EXPOSURE LIMITS FOR PPPL RADIATION WORKERS

The PPPL Director, with the advice of the Environmental, Safety, and Health Executive Board (ES&H-EB), annually establishes the PPPL Administrative Control Level. The PPPL Administrative Control Level is 1,000 mrem per calendar year per person and 600 mrem per calendar quarter. Administrative exposure limits can only be exceeded by approval of the ES&H-EB.

SUBPART D - (RESERVED)

SUBPART E - MONITORING IN THE WORKPLACE

10.401 GENERAL REQUIREMENTS

Monitoring of individuals and areas is performed to meet the following objectives.

- To reduce radiation exposure
- To verify the effectiveness of engineering and process controls in containing radioactive material
- To detect changes in radiological conditions
- To detect the gradual buildup of radioactive material in the workplace
- To document radiological conditions in the workplace
- To demonstrate compliance with 10 CFR 835

Area monitoring in the workplace shall be routinely performed, as necessary, to identify and control potential sources of personnel exposure to radiation and/or radioactive material.

Instruments used for monitoring and contamination control shall be periodically maintained and calibrated on an established frequency of at least once per year. They shall be appropriate for the type(s), levels, and energies of the radiation(s) encountered at PPPL and chosen to operate in existing environmental conditions. They shall be routinely tested for operability.

10.402 INDIVIDUAL MONITORING

Personnel dosimetry devices are provided to and used by individuals who have access to PPPL and who are likely to receive a yearly dose equivalent equal to, or more than, the values shown in Table 10.3.

Table 10.3

TYPE OF EXPOSURE	DOSIMETER ISSUED (Eff. Dose Equiv.)
Radiological Worker: Whole body - External Radiation	≥ 0.1 rem
Radiological Worker: Lens of the Eye	≥1.5 rem
Radiological Worker: Shallow dose equivalent to Skin or any Extremity	≥ 5 rem
Radiological Worker: Deep Dose equivalent to any organ or tissue	≥ 5 rem
Declared Pregnant Workers	≥ 0.05 rem**
Minors and Members of the Public	≥ 0.05 rem
Individuals entering a High or Very High Radiation Area	All

* Other than to the lens of the eye.
** Period of conception to birth

The PPPL external dosimetry program shall be adequate to demonstrate compliance with the values shown in Section 10.202. Dosimeters shall be routinely calibrated and conform with the requirements of the DOE Laboratory Accreditation Program (DOELAP) for Personnel Dosimetry.

Routine bioassay is provided for individuals who have access to PPPL and who are likely to receive the committed effective dose equivalent noted in Table 10.4.

Table 10.4

TYPE OF EXPOSURE	BIOASSAY INITIATED (Committed Effective Dose Equivalent)
Radiological Worker	≥ 0. 1 rem
Radiological Worker: Weighted Dose equivalent to any organ or tissue	≥ 5 rem
Declared Pregnant Worker*	≥ 0.05 rem*
Minors and Members of the Public	≥ 0.05 rem

* Period of Conception to Birth

PPPL internal dose evaluation programs shall be adequate to demonstrate compliance with Section 10-202.

10.403 AREA MONITORING

Area monitoring at PPPL consists of performing measurements of radioactivity concentrations in the ambient air (air monitoring), the taking of dose rate measurements, and the assessment of surfaces to detect and measure radioactive contamination.

Air monitoring shall be performed in occupied areas where, under typical conditions, an individual is likely to receive an annual intake of 2 percent or more of the specified Annual Limit on Intake (ALI) values. For a given radionuclide and lung retention class, the ALI is the product of the Derived Air Concentration (DAC) for that particular radionuclide listed in appendix A and the constant 2.4 x 1 01 ml. Air samples shall be taken as necessary to detect and evaluate the level or concentration of airborne radioactive material at work locations.

Real time air monitoring, using continuous air monitors, shall be performed in normally occupied areas where an individual is likely to be exposed to a concentration of airborne radioactivity exceeding 1 DAC, or where there is a need to alert potentially exposed individuals to unexpected increases in airborne radioactivity levels. Nonportable, real time air monitors shall have alarm capability and sufficient sensitivity to alert potentially exposed individuals that immediate action is necessary in order to minimize or terminate inhalation exposures.

Dose rate measurements are taken in the workplace at PPPL using stationary or portable radiation instruments, as the situation dictates. Instruments for taking dose rates shall be readily available and capable of measuring ambient radiation dose rates for the purpose of controlling radiation exposures.

Appendix D lists the limits for considering surfaces contaminated with radioactive materials. PPPL accepts these values for the purpose of controlling the inadvertent spread of radioactive contamination. They apply to

radioactive contamination deposited on, but not incorporated into, the interior of the contaminated item.

10.404 RADIOACTIVE CONTAMINATION CONTROL AND MONITORING

Instruments and techniques used for radioactive contamination monitoring and control shall be adequate to ensure compliance with the requirements of this section. The amount of removable radioactive material per 100 cm^2 of surface area is determined by swiping the area with dry filter or soft absorbent paper, or in the case of tritium, a moist cotton swab, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area is based on the actual area and the entire surface shall be wiped.

Appropriate controls shall be maintained and verified to prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions.

Any area in where contamination levels exceed the values specified in appendix D shall be posted in accordance with Section 10.603, and shall be controlled in a manner commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present and the fixed and removable contamination levels.

Fixed contamination areas that exceed the values of appendix D, shall be tolerated outside of radiological areas provided the following conditions are met:

- Removable contamination levels are below the levels specified in appendix D.
- Unrestricted access to the area is not likely to cause any individual to receive a total effective dose equivalent in excess of 0.1 rem in a year.
- The area is routinely monitored.
- The area is clearly marked to alert personnel of the contaminated status.
- Appropriate administrative procedures are established and exercised to maintain control of these areas.
- Dose rates do not exceed levels which would require posting in accordance with Section 10.603.

The entry controls and posting detailed in Sections 10.501 and 10.603, below are not required for areas with fixed contamination that meets the conditions of this section.

Appropriate monitoring shall be performed by individuals exiting radiological areas established to control removable contamination and/or airborne radioactivity.

The use of protective clothing shall be required for entry into areas where removable contamination exists at levels exceeding those specified in appendix D.

SUBPART F ENTRY CONTROL PROGRAM

10.501 RADIOLOGICAL CONTROLLED AREAS (RCAs)

At PPPL, access control is maintained for each radiological area and is considered a major element in the ALARA program. The degree of training in radiological safety practices and the need to perform tasks govern the access to RCAs. The degree of control is commensurate with existing and potential radiological conditions within the area.

One or more of the following methods shall be used to ensure access control to radiological areas:

- Radiation caution signs and barricades
- Control devices on entrances
- Conspicuous visual and/or audible alarms
- Locked entrance ways
- Administrative Controls

Administrative procedures shall be developed to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Authorizations in the form of work permits issued by operations management to perform specific work in radiological areas shall be required. Radiation work permits that describe radiological conditions and include specific radiation protection measures shall be required for access to controlled areas. No control may be installed at any RCA exit that would prevent rapid evacuation of personnel under emergency conditions.

10.502 HIGH AND VERY HIGH RADIATION AREAS

One or more of the following features shall be used for each entrance or access point to a high radiation area where radiation levels exist such that an individual could exceed a deep dose equivalent to the whole body of 1 rem in any one hour at 30 centimeters from the source or from any surface that the radiation penetrates:

- A control device that prevents entry to the area when high radiation levels exist or that upon entry causes the radiation level to be reduced below the level defining a high radiation area.
- A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area.
- A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.
- Entryways that are locked. During periods when access to the area is required, positive control over each entry shall be maintained.

- Continuous direct or electronic surveillance that is capable of preventing unauthorized entry.
- A control device that automatically generates audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

In addition to the features described here, area searches and the use of capture key systems shall be used to prevent personnel from entering or being caught in Very High Radiation Areas during operations.

No control shall be established that would prevent the rapid evacuation of personnel from high or very high radiation areas under emergency conditions.

SUBPART G POSTING AND LABELING

10.601 GENERAL REQUIREMENTS

DOE approved radiological postings shall be used to alert personnel to the presence of radiation and radioactive materials, to aid them in minimizing exposures, and to prevent the spread of contamination. They shall contain the standard radiation symbol colored magenta on a yellow background. Lettering shall be magenta. Radiological postings shall be displayed only to signify actual or potential radiological conditions. The signs required shall be clear, legible, and conspicuously posted and may include radiological protection instructions. Postings used for training shall be clearly marked, "For Training Purposes Only." Radioactive items or containers of radioactive materials shall be individually labeled if adequate warning is not provided by control measures and required posting.

10.602 CONTROLLED AREAS

Each access point to controlled areas shall be posted identifying it as a controlled area whenever radioactive material and/or radiation fields which would require posting under the provisions of section 10.603, may be present in the area.

10.603 RADIOLOGICALLY CONTROLLED AREAS

Each access point to a radiologically consoled area shall be posted with conspicuous signs bearing the wording described in Table 10.5.

Table 10.5

AREA	CRITERIA	POSTING
Radiation Area	> 0.005 rem/hr and ≤ 0. 1 rem/hr*	"CAUTION, RADIATION AREA" "Dosimeter Badge and RWP Required for Entry"
High Radiation Area	> 0. 1 rem/hr and ≤500 rad/hr*	"DANGER, HIGH RADIATION AREA" "Dosimeter Badge, Supplemental Dosimeter and RWP Required for Entry"
Very High Radiation Area	>500 rad/hr**	"GRAVE DANGER, VERY HIGH RADIATION "SPECIAL CONTROLS REQUIRED FOR ENTRY"
Contamination	>Appendix D values and <100 times Appendix D values	"CAUTION, CONTAMINATION AREA" "RWP Required for Entry"
High Contamination	>100 times Appendix D values	"DANGER, HIGH CONTAMINATION AREA " "RWP Required for Entry"
Radioactive Materials Area	Areas where radioactive materials are used or stored	"CAUTION, RADIOACTIVE MATERIALS"
Airborne Radioactivity	CONCENTRATIONS > 10% of any DAC value	"CAUTION, AIRBORNE RADIOACTIVITY AREA" "RWP Required for Entry"

* Measured at 30 centimeters from the radiation source or any surface the radiation penetrates.
** Measured at 1 meter from the radiation source or any surface the radiation penetrates.

SUBPART H RECORDS

10.701 GENERAL PROVISIONS

The records generated as a result of the PPPL radiation protection program are maintained to document compliance with 10 CFR 835 and with the provisions of this RPP. Unless otherwise specified, records shall be retained until disposition is authorized by the DOE.

10.702 INDIVIDUAL MONITORING RECORDS

Records shall be maintained to document radiation doses received by all individuals at PPPL for whom routine, occupational monitoring is required by Section 10.402, and for radiation doses received during planned special exposures, accidents, and emergency conditions. In addition, the results of individual external and internal dose measurements that are performed, but are not required by Section 10.402 shall be recorded. Recording of non uniform shallow dose equivalent shall not be required if the dose is less than 2 percent of the limit specified for the skin in Section 10.202.

The records required by this Section shall be sufficient to evaluate compliance with the provisions of Section 10.202, and to provide dose information necessary to complete the reports required by Subpart I of this RPP and DOE requirements for occurrence reporting and processing. They shall include the following quantities for dose received during the year:

- The effective dose equivalent from external sources of radiation (deep dose equivalent is used as effective dose equivalent for external exposure).
- The lens of the eye dose equivalent.
- The shallow dose equivalent to the skin and extremities.
- Committed effective dose equivalent.
- Committed dose equivalent to any organ or tissue of concern.
- Estimated intake and identity of radionuclides.
- Total effective dose equivalent in a year.
- For any organ or tissue assigned an internal dose during the year, the sum of the deep dose equivalent from external exposures and the committed dose equivalent to that organ or tissue.
- Cumulative total effective dose equivalent received from external and internal sources while employed at PPPL since January 1, 1989.
- The dose equivalent to the embryo/fetus of declared pregnant workers.

Documentation of all occupational exposures received during the current year shall be obtained to demonstrate compliance with the provisions of Section 10.202. In the absence of formal records of previous occupational exposure during the year, a written estimate signed by the individual shall be accepted. Efforts shall be made to obtain records of prior years' occupational internal and external exposure.

The records specified in this RPP that are identified with a specific individual shall be readily available to that individual.

Data necessary to allow future verification or reassessment of the recorded doses shall be recorded. All records required by this Section shall be transferred to the DOE upon cessation of activities at PPPL that could cause exposure to individuals.

10.703 MONITORING AND WORKPLACE RECORDS

The following information shall be documented and maintained as official record:

- The results of the surveys of airborne radioactivity, ambient radiation, and radioactive material contamination.
- The results of surveys, measurements, and calculations used to determine individual occupational exposure from external and internal sources.
- The results of surveys for the release of material and equipment.
- The results of maintenance and calibration performed on instruments used for area monitoring and contamination control and for devices used for individual monitoring.

10.704 ADMINISTRATIVE RECORDS

The following administrative information shall be documented and maintained as official record:

- Training records to demonstrate compliance with the provisions of Subpart J.
- Actions taken to maintain occupational exposures ALARA, including the actions required for this purpose by Section 10. 10 1, and facility design and control actions required by Subpart K.
- Records documenting the results of internal audits and other reviews of program content and implementation.
- Written declarations of pregnancy.
- Changes in equipment, techniques, and procedures used for monitoring the workplace.

SUBPART I REPORTS TO INDIVIDUALS

10.801 REPORTS TO INDIVIDUALS

Individuals monitored in accordance with Section 10.402 shall receive reports as required by Section 10-702. Each notification and/or report is made in writing and includes the DOE facility name (PPPL), the name of the individual, and the individual's social security number or employee number. The following paragraphs describe these reports and/or notifications.

Upon request from an individual terminating employment, records of exposure shall be provided to that individual as soon as the data are available, but not later than 90 days after termination. A written estimate of the radiation dose received by that employee based on available information shall be provided at the time of termination, if requested.

PPPL shall provide an annual radiation dose report to each individual monitored during the year at PPPL.

Detailed information concerning any individual's exposure is made available to that individual upon request of the individual, consistent with the provisions of the Privacy Act (5 U.S.C. 552a).

Any exposure of individuals to radiation and/or radioactive material, or planned special exposure requiring PPPL to report to DOE for occurrence reporting and processing, shall result in a report to the individual as well. This report will be provided at the same time the information is transmitted to the DOE.

SUBPART J RADIATION SAFETY TRAINING

10.901 GENERAL EMPLOYEES

All general employees shall be trained in radiation safety prior to receiving occupational exposure during access to controlled areas at PPPL. Allowance may be made for previous DOE training on generic radiation safety topics, provided the training was received at another DOE site within the past 2 years. Documentation of the previous training must clearly identify the individual's name, date of training, topics covered, and name of the certifying individual. The knowledge of radiation safety possessed by general employees is verified by examination.

Retraining of general employees is provided when there is a significant change to radiation protection policies and procedures that affect general employees and is also required at intervals not to exceed 2 years.

10.902 RADIOLOGICAL WORKERS

At PPPL, Radiological Worker training shall familiarize the worker with the fundamentals of radiation protection and the ALARA process. Retraining shall be required at intervals not to exceed 2 years. Training shall include both classroom and on-the-job (applied) training. Training shall precede assignment as a radiological worker or can be concurrent with assignment as a radiological worker if the worker is accompanied by and is under the direct supervision of a trained radiological worker.

Radiological worker training, not specific to PPPL, may be waived provided that this training has been received at another DOE site within the past 2 years. There must be proof-of-training in the form of a certification document that contains the individual's name, date of training, and the specific topics covered. An appropriate official must have certified the training of the individual. The knowledge of radiation safety possessed by radiological workers shall be verified by examination prior to an unsupervised assignment.

Radiological worker training shall include procedures specific to an individual's job assignment. The level of training shall be commensurate with each worker's assignment.

10.903 HEALTH PHYSICS TECHNICIANS

Training and retraining programs for Health Physics Technicians shall be established and are to be conducted at intervals not to exceed 2 years. These programs shall be designed to familiarize technicians with the fundamentals of radiation protection and the proper procedures for maintaining exposures ALARA. Training programs shall include both classroom and applied training.

Training shall either precede performance of tasks assigned to Health Physics Technicians or can be concurrent with such task assignments if the individual is accompanied by and is under the direct supervision of a trained individual.

The required level of knowledge of Health Physics Technicians shall be verified by examination to include demonstration prior to any unsupervised work assignment. The training program shall include procedures specific to PPPL. The level of training shall be commensurate with the technician's assignment. Allowance may be made for previous DOE training on generic radiation safety topics, provided the training was received within the past 2 years. Documentation of the previous training must clearly identify the individual's name, date of training, topics covered, and the name of the certifying individual.

SUBPART K DESIGN AND CONTROL

10.1001 DESIGN AND CONTROL

Measures shall be taken to maintain radiation exposures in controlled areas ALARA through facility and equipment design and administrative control. The primary methods used shall be physical design features such as, confinement, ventilation, remote handling, and shielding. Administrative controls and procedural requirements are employed only as supplemental methods to control radiation exposure.

For specific activities where use of physical design features are demonstrated to be impractical, administrative controls and procedural requirements shall be used to maintain radiation exposures ALARA.

10.1002 FACILITY DESIGN AND MODIFICATIONS

The following objectives shall be adopted for use during the design of new facilities or for the modification of old facilities:

- Optimization methods shall be used in developing and justifying facility design and physical controls to assure that occupational exposure is maintained ALARA.

- The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2000 hours per year) shall be to maintain exposure levels below an average of 0.5 mrem per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for potential exposure to a radiological worker where occupancy differs from the above are ALARA and shall not exceed 20 percent of the applicable standards in Section 10.202.

- The design objective for controlling airborne radioactivity shall be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA. Confinement and ventilation shall normally be used for this purpose.

- The design and modification of facilities and the selection of materials shall include features that facilitate operations, maintenance, shutdown and removal.

10.1003 CONTROL PROCEDURES

- During routine operations, the combination of design features and administrative control procedures shall provide that:

- The anticipated magnitude of the total effective dose equivalent does not exceed 5 rem in a year;

- The anticipated magnitude of the committed dose equivalent to any organ or tissue, plus any deep dose equivalent from external exposure, shall not exceed 50 rem in a year.

- Exposure levels are maintained ALARA.

Compliance with these requirements shall be demonstrated by appropriate monitoring according to Subpart E.

SUBPART L RELEASE OF MATERIALS AND EQUIPMENT FROM RADIOLOGICAL AREAS

10.1101 RELEASE OF MATERIALS AND EQUIPMENT FROM RADIOLOGICAL AREAS

The following requirements shall apply at PPPL for the release of materials and equipment from RCAs:

Radioactive material in Contamination, High Contamination or Airborne Radioactivity Areas shall be surveyed prior to release. Radioactive material to be released for unrestricted use must demonstrate that contamination levels on accessible surfaces are less than the values shown in appendix D and that prior use does not suggest that the contamination levels on inaccessible surfaces exceed appendix D values.

Material and equipment that exceeds the total or removable contamination levels specified in appendix D shall be conditionally released for movement on-site from one RCA for immediate placement in another RCA if monitored, packaged, and labeled appropriately.

Materials and equipment with fixed contamination levels that exceed the limits specified in appendix D may not be released for unrestricted area's use.

Records for release of material and equipment shall describe the property, indicate the date the release survey was performed, identify the individual who performed the survey, indicate the type and identification number of the survey instrument used, and show survey results.

SUBPART M (RESERVED)

SUBPART N ACCIDENTS AND EMERGENCIES

10.1301 GENERAL PROVISIONS

A PPPL employee whose occupational exposure has exceeded any of the limits specified in Section 10.202 or 10.205 may be permitted to return to work in radiological areas during the current year providing that all of the following conditions are met:

- Approval shall first be obtained from the PPPL management and the Head of the responsible DOE field organization.
- The individual shall receive counseling from radiological protection and medical personnel regarding the consequences of receiving additional occupational exposure during the year.
- The affected employee agrees to return to radiological work.

All exposures at PPPL that exceed the limits specified in Section 10.202 or 10.205 shall be recorded in the affected individual's occupational exposure file and reported to the DOE in accordance with DOE requirements for occurrence reporting and processing.

When the conditions under which the emergency or accident exposures were received have been eliminated, operating management shall notify the Head of the responsible DOE field organization. Operations after an emergency or accidental exposure in excess of the limits shown in Section 10.202 or 10.205 shall be resumed only with the approval of the DOE.

Occurrence reports to the DOE regarding emergencies and/or accidents shall be prepared and submitted in accordance with DOE requirements for occurrence reporting and processing.

10.1302 EMERGENCY EXPOSURE SITUATIONS

The risk of injury to those individuals involved in rescue and recovery operations shall be minimized. PPPL operating management weighs actual and potential risks to rescue and recovery personnel against the benefits

to be gained. Rescue actions that might involve substantial personal risk are performed by volunteers. The dose limits for individuals who perform these operations are as follows:

Table 10.6

Dose Limit* (Whole Body)	**Activity Performed**	**Conditions**
5 rem	All.....	None.....
10 rem	Protecting Major Property	Where lower dose limit is not practical
25 rem	Lifesaving or protection of large populations	Where lower dose limit is not practical
>25 rem	Lifesaving or protection of large populations of the risks involved	Only on a voluntary basis to personnel fully aware

* The lens of the eye dose limit is three times the listed values. The shallow dose limit to the skin of the whole body and the extremities is ten times the listed values. These doses are in addition to and accounted for separately from the doses received under the limits shown in Section 10.202.

Each individual selected shall be trained in accordance with the provisions of Section 10.902 and briefed before hand with respect to the known or anticipated hazards to which the individual will be subjected.

SUBPART 0 CONTROL OF SOURCES OF RADIATION

10.1400 GENERAL INFORMATION

The Health Physics Division (HPD) shall provide radiation safety oversight in the acquisition, use, transport and disposal of sources of radiation at PPPL. Sources of radiation covered by this policy include radionuclides, equipment containing radionuclides (e.g. fission detectors) and radiation producing machines (RPMs). RPMs include small plasma devices, X-ray machines, rf modulators, particle accelerators, and neutron generators.

10.1401 USER QUALIFICATION

Only individuals who are qualified by the HPD through training and experience (Authorized Users) shall use and control sources of radiation at PPPL. The HPD shall maintain a listing of all Authorized Users together with a record of their training and experience. The Office of Certification and Training (OCT), with the assistance of the HPD, shall provide training in the various aspects of radiation safety to those individuals who require Authorized User status to perform tasks that require the use of radiation sources.

10.1402 SOURCE ACQUISITION

All requests for sources, no matter how they are to be acquired, shall be approved by the HPD prior to their acquisition. No radiation source shall be purchased, brought to, or taken from PPPL without prior written approval by the BPD. Individuals who plan to acquire radiation sources shall demonstrate, through the development of procedures, that the material or device will be used in a manner consistent with legal and Laboratory requirements and that sound radiation safety practices shall be employed to ensure that radiation exposures from the source will be kept As Low As Reasonably Achievable. The HPD shall review and approve all source acquisition applications and proposed source use procedures.

10.1403 SOURCE RECEIPT

The Materiel Control Branch (MCB) shall receive all incoming shipments that include radiation sources except for large activity sources. MCB shall notify HPD when a radiation source arrives at PPPL. HPD shall inspect and monitor the shipment for contamination and radiation levels before it is delivered. Once a source is accepted it shall be added to the PPPL source inventory maintained by HPD.

10.1404 SOURCE ACCOUNTABILITY AND CONTROL

Only Authorized Users may use sources of radiation at PPPL. Each radiation source at PPPL, whether isotopic or radiation generating device shall be assigned to a Prime Authorized User for accountability and radiation safety purposes. This individual is an Authorized User who shall be responsible to ensure that only individuals that have been qualified by the HPD to use the source shall have access to it and that the sources they are responsible for are stored in a secure manner when not in use. Prime Authorized Users shall ensure compliance with the following:

- Isotopic sources shall be kept in a locked cabinet approved by the HPD for this purpose when they are not in use.
- A log shall be kept for removal and return of sources from their storage cabinets.
- Authorized source storage cabinets containing sources shall be properly posted.
- Personnel dosimeters shall be worn by all individuals involved when using radioactive sources or when using a machine that can produce radiation.
- Appropriate radiation warning signs shall be displayed while sources are in use in accordance with this Section.
- Users shall not lend sources without the written permission of the HPD.
- Users shall use sources only in a manner approved on a Radiation Work Permit.
- The HPD must be notified before-any radioactive source is transported past the vicinity of any environmental radiation monitor, e.g., D-Site Facility Boundary Trailers.

- The budget for acquisition and use of radiation sources shall include necessary shielding, monitoring equipment, and any other equipment or materials needed for safe operation.

The HPD shall be responsible for meeting all DOE and other legal reporting and documentation requirements with respect to radiation sources. They shall remain cognizant of the location and use of sources and shall provide guidance in their selection and safe use. HPD shall perform routine leak tests and inventory checks at intervals not exceeding 6 months and shall ensure that sources exhibit their PPPL source number, and in the case of radioisotopes, isotope name, original activity and date of original activity.

10.1405 RADIOGRAPHIC SOURCES

The following requirements apply to the use of radiographic devices at PPPL:

- A radiation work permit (RWP) shall be written and approved by the HPD before any radiography source may be brought on-site at PPPL. This RWP shall include emergency steps that shall be taken should the source become stuck in an exposed position.

- The HPD shall be notified when a radiography source arrives at PPPL so that the source can be inspected and monitored and its arrival documented.

- The BPD shall provide continuous radiation safety supervision while the source is in use.

- When possible, radiography shall be scheduled outside normal working hours to reduce possible exposure to personnel not directly involved in the procedure.

- Radiography shall be avoided in occupied buildings whenever possible.

10.1406 INTERLOCKS AND EXCLUSION AREAS

The following applies to the use of interlocks and exclusion areas in connection with the operation of RPMs:

- Exclusion areas shall be defined in the operating procedure when a RPM is proposed for acquisition.

- Access to exclusion areas shall be controlled by fail-safe interlocks installed in such a manner that the safe condition is established by a shutdown device(s) before entry is possible.

- Exclusion areas where radiation levels could result in exposures in excess of PPPL administrative dose equivalent action levels shall have at least two fail-safe shutdown devices.

- Interlocks and shutdown devices shall be tested for proper operation prior to startup of a new or modified facility, after prolonged shutdown of an existing facility, and at intervals not to exceed 6 months at a continuously operating facility. These tests shall be documented.

- Bypassing of safety interlocks can be permitted only after being authorized by the Division

Head on an individual basis and after a radiation survey has verified that no significant hazard will exist under the conditions of the authorization. The bypass shall be made as conspicuous as possible, kept under continuous surveillance and shall be removed at the earliest opportunity. The circuit shall be tested following the removal of a bypass to assure its proper operation.

10.1407 MONITORING AND WARNING INDICATORS

The following applies to the use of monitoring and warning indicators in connection with the operation of RPMs:

- Automatic audible warning shall be activated in exclusion areas prior to turn-on of the RPM. Sufficient time shall be allowed between the warning and startup of the RPM to permit exit from the area without use of an emergency shutdown switch.

- Automatic warning lights or illuminated signs shall be installed at all entrances to define exclusion areas and inside large exclusion areas. They shall be activated by the "beam on" condition to indicate real or potential hazardous radiation levels.

- Continuous radiation monitoring shall be installed in radiologically controlled areas associated with RPMS. These monitors shall be equipped with local alarms which inform operating personnel of any hazardous increases of radiation levels.

10.1408 SHIELDING

The following applies to the use of shielding in connection with the operation of RPMS:

- Fixed shielding shall be installed to ensure that radiation levels in occupied areas do not result in personnel exposures that exceed PPPL administrative action levels.

- Shielding shall be designed for the foreseeable maximum radiation hazard that a particular RPM can generate. Design levels in occupied areas outside the shield shall be kept ALARA, and shall not exceed 0.5 mrem/hr.

- Provision shall be made for installation of local shielding as needed for short term conditions of an unusual nature.

10.1409 ANALYTICAL X-RAY EQUIPMENT

The following applies to the use of analytical X-ray equipment.

- A warning light of fail safe design labeled with the words "X-rays ON" shall be conspicuously located near the X-ray tube to indicate when the X-ray tube is activated.

- A sign or label indicating "CAUTION-X-RAYS PRODUCED WHEN ENERGIZED" shall be placed near any switch which energizes an X-ray tube.

- The dose due to unwanted radiation from components such as high voltage rectifiers shall not exceed 1 mrem in a week in any accessible region 5 cm from the outside surface of the generator cabinet. Assuming that an individual may be in the vicinity of the equipment while it is operating for as long as 40 hours per week, the dose rate shall not exceed 0.5 mrem.

- Normal operational and alignment procedures shall be documented by the manufacturer of the X-ray system, or by the facility user if the source housing and X-ray accessory apparatus are not compatible components supplied by the same manufacturer.

- Normal operating and alignment procedures shall be such that a qualified operator following instructions will not receive in any one hour a dose equivalent in excess of 37.5 mrem to the hands and forearms, or 2.5 mrem to the whole body, gonads, blood-forming organs or lens of the eye.

10.1410 CLOSED BEAM DIFFRACTOMETERS AND SPECTROGRAPHIC EQUIPMENT

The following applies to the use of closed beam diffractometers and spectrographic equipment:

- The radiation source, sample, detector and analyzing crystal (if used) shall be enclosed in a chamber or coupled chambers that cannot be entered by any part of the body during normal operations.

- The inherent shielding of the chamber walls shall be sufficient to limit the dose rate in all regions 5 cm from its outer surface to 0.5 mrem/hour during normal operations.

- The sample chamber enclosure shall be interlocked, by a fail safe method, with the X-ray tube high voltage supply or a shutter in the primary beam so that no X-ray beam can enter the sample chamber while it is open unless the interlock has been consciously and deliberately defeated and conspicuously posted.

10.1411 OPEN BEAM X-RAY EQUIPMENT

The following applies to the use of open beam X-ray equipment. Any X-ray system that does not comply with the provisions of Section 10.1410 shall be classified as an open beam X-ray system.

- All shutters shall be provided with a "shutter open" indication of fail safe design.

- Radiation levels external to the X-ray tube housing with all shutters closed shall not exceed 2.5 mrem/hour as measured 5 cm from the surface of the housing within which an X-ray tube is operating at full rated power and at maximum rated accelerating potential.

- Each port of the X-ray system shall be provided with a beam shutter interlocked with the X-

- ray accessory apparatus coupling or collimator, in such a way that the port will be open only when the collimator or coupling is in place. Shutters at unused ports shall be secured to prevent casual opening.
- A guard or interlock which prevents entry of any part of the body into the primary beam path shall be utilized.
- A system barrier shall be provided so that the dose equivalent received by individuals in the controlled area is as low as reasonably achievable but does not exceed 2.5 mrem in any one hour or 100 mrem in any five consecutive days.

SUBPART P RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

10.1500 GENERAL INFORMATION

The Radiological Environmental Monitoring Program (REMP) is maintained to demonstrate compliance with DOE limits for release of radioactive materials to the environment and for radiation produced by PPPL operations which can be measured at or beyond the PPPL property line. In addition, the program is designed to provide "open information" to the public on the environmental impact of the facility and its operation.

10.1501 DOSE EQUIVALENT LIMITS FOR THE PUBLIC FROM PPPL

The effective dose equivalent for any member of the general public from all routine operations (natural background and medical exposures excluded) shall not exceed the limits in Table 10.7.

Table 10.7

Table of Effective Dose Equivalent Limits for the Public from PPPL Operations

PATHWAY	LEGAL LIMIT (mrem/year)	ADMINISTRATIVE LIMIT
All	100	10*
Air,**	10	----
Drinking Water***	4	----

* TFTR design objective
** NESHAPS requirement
***Title 40 Code of Federal Regulations, Part 14
---- No established limit