DOE PRINCETON PLASMA PHYSICS LABORATORY

RADIATION PROTECTION PROGRAM

REVISION 9

George Ascione

Digitally signed by George Ascione
DN: cn=George Ascione, o=Health Physics, ou=ES&H, email=gascione@pppl.gov, c=US
Date: 2016.06.02 07:43:44 -04'00'

George Ascione **Date**
Head, Health Physics & Nuclear MC&A

Jerry D. Levine

Digitally signed by Jerry D. Levine
DN: cn=Jerry D. Levine, o=Princeton Plasma Physics Laboratory, ou=ESH&S Department, email=jlevine@pppl.gov, c=US
Date: 2016.06.02 07:46:45 -04'00'

Jerry Levine **Date**
Head, Environment, Safety, Health & Security

1.0 Introduction

This document is the Radiation Protection Program (RPP) required by 10CFR835.101 for activities conducted at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL), which is managed by Princeton University. PPPL is a collaborative national center for plasma and fusion science, and is dedicated to developing fusion as a clean and abundant source of energy and to advancing the frontiers of plasma science. The Laboratory pursues these goals through experiments and computer simulations of the behavior of plasma, the hot, electrically-charged gas that fuels fusion reactions and has a wide range of practical applications.

PPPL advances the coupled fields of fusion energy and plasma physics research and, with collaborators, is developing the scientific understanding and key innovations needed to realize fusion as an energy source for the world. The National Spherical Torus Experiment (NSTX) is a collaborative project among U.S. laboratories, including Department of Energy National Laboratories, universities, and institutions, as well as international institutes. Also located at PPPL are smaller experimental devices, such as the Magnetic Reconnection Experiment (MRX), the Lithium Tokamak Experiment (LTX) and Hall Thruster, which investigate plasma physics phenomena. PPPL also conducts theoretical plasma physics research and mathematical simulation of plasma physics phenomena as well as advancing graduate education in plasma physics.

2.0 Scope (Sources of Ionizing Radiation, Facilities, Activities)

This section addresses the sources of radiation exposure for the facilities and/or activities that are within the scope of this RPP. The implementing polices, plans, and procedures for each applicable requirement of 10CFR835 are contained in a separate "evidence file" which is maintained and available for review, but not considered part of the formal RPP. As indicated in the table that follows this section, all areas of the PPPL Radiation Protection Program that have not been previously exempted are in full compliance with the applicable requirements of 10CFR835.

2.1 NSTX Test Cell. Neutron and gamma/x radiation is generated from plasmas when the National Spherical Torus Experiment (NSTX) is operating. The neutron spectrum generated by the NSTX peaks at approximately 2.5 MeV. During operation, the NSTX is isolated in its test cell equipped with shielding walls designed to attenuate radiation levels so that radiation workers do not receive total effective dose equivalents of more than 100 mrem per calendar year. This includes the sealing of wall penetrations where necessary to optimize shielding effectiveness. In addition, interlocks and administrative procedures are used to limit worker exposure. The most significant contribution to the dose equivalent outside the NSTX test cell shield wall is from prompt neutron and gamma radiation: D-D neutrons ($\leq$2.5 MeV), and gamma/X photons up to 2 MeV. Periodic dosimeter performance testing is done at the most appropriate energy levels for the facility.

2.2 PPPL Environmental, Analytical & Radiological Laboratory (PEARL), Health Physics Calibration & Services Laboratory (CASL), Radioactive Waste Handling Facility and D-Site Count Room, NSTX Test Cell (Vacuum Vessel). Neutron, beta, alpha, X and gamma radiation from sealed calibration and check sources used and stored in these facilities contribute to the potential for exposure at PPPL. These sources (e.g., Cs-137, Pu-239, Cf-252, etc.) are used to check and calibrate both experimental detectors and Health Physics instrumentation used in radiological control activities. Sources of this type are sealed. When the check sources are not in use they are kept in controlled storage locations.

2.3 Former TFTR Test Cell, NSTX Test Cell, Mockup Building RF Enclosure, Radioactive Waste Handling Facility: Gamma radiation from induced activation of National Spherical Torus Experiment (NSTX) machine components and numerous decayed components from the Tokamak Fusion Test Reactor (TFTR) and in storage containers in the Radwaste Handling Facility comprise a source of external exposure (e.g., from Co-60, Mn-56, etc.). Exposures to this source of radiation are controlled through the use of shielding and administrative procedures.

2.4 CASL: Neutron, beta, X and gamma radiation from neutron generators used in diagnostic studies provide a potential for measurable exposure. Exposures from these devices are controlled by isolating devices while in operation, and through the use of shielding, interlocks and administrative procedures.

2.5 D-Site Neutral Beam Power Conversion Building: X-rays from Neutral Beam Modulator Regulators for NSTX operations are an intermittent source of radiation exposure. Low energy x-rays (~100 kev) are produced whenever the modulators regulators are energized. Fields of < 1 mrem/hr have been measured. Access to these fields is controlled administratively.

2.6 Various Locations at C and D-Site: Miscellaneous small experiments on C and D-Site utilize various radionuclides. Potential shallow exposures may exist from experiments while handling radionuclides emitting low energy x-ray, betas or gammas. Most exposures would be to the extremities, however the potential may exist for whole body shallow and/or deep exposure. Examples of exposure potential include, but are not limited to, the use of labeled radionuclides (e.g., Na-22) for tracer experiments. Experiments on C-site sometimes involve X-ray generating analytical equipment, or use high voltage sources that, once coupled to a plasma, produce X-rays. Relevant areas primarily include C-Site Laboratory Wing, PEARL, CASL, and the D-Site Tritium Area. Exposures to these sources of radiation are controlled through the use of shielding, interlocks and administrative procedures.

2.7 Sources of Internal Radiation Exposure: These include

- Tritium gas and tritium oxide either produced by the generation of deuterium plasmas or received from outside suppliers and other laboratories (e.g., JET vacuum vessel tiles), in holdup and component systems, Tritium Area,

formerly used TFTR Tritium Purification System, contaminated neutral beam boxes in the former TFTR Test Cell and in the NSTX Test Cell, and in the Radioactive Waste Handling Facility.

Exposures to these sources of radiation are controlled through the use of engineering controls (e.g., glove box containment, negative pressure confinement, shielding, etc.), administrative procedures and personal protective equipment.