Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Princeton Plasma Physics Laboratory

Nuclear Materials Control and Accountability Plan

Plan Number: HP-PP-06 Revision: 4
Effective Date: Expiration Date:

Prepared By:

Catherine Saville date
Nuclear Materials Representative

Reviewed By:

George Ascione date
Safeguards Manager

Jerry Levine date
Head, ES&H Division

Jack W. Anderson date
Head, ES&H and Infrastructure Department

Jerry Faul date
Area Manager DOE/PG

Thomas A. Gradle date
Director, Safeguards and Security Division
DOE/Chicago Operations

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

1. Introduction....1

1.1 Purpose....1

1.2 Scope....1

1.3 Overview....1

1.4 Issuance and Approval....1

1.5 References....1

1.6 Definitions....2

1.7 Acronyms and Initialisms....5

2. Organization and Administration....6

2.1 Organizational Structure....6

2.2 Responsibilities and Authorities....7

2.2.1 DOE/CH Division of Safeguards and Security....7
2.2.2 DOE Princeton Group....7
2.2.3 Director of Princeton Plasma Physics Laboratory....7
2.2.4 Department Head, ES&H....7
2.2.5 Safeguards Manager....7
2.2.6 Nuclear Materials Representative....7
2.2.7 Nuclear Materials Custodian....8
2.2.8 Seals Custodians....8
2.2.9 Health Physics Branch....8
2.2.10 Materiel Control Division....8

2.3 PPPL Communications Information....8

3. Nuclear Material Attractiveness and Categorization....9

3.1 Background....9

3.2 Classification of Nuclear Materials at PPPL....9

4. Material Control....10

4.1 Facility Overview....11

4.1.1 Facility Description....12
4.1.2 General Plant Security....12
4.1.3 Personnel Access Requirements....13

4.2 Material Containment....13

4.2.1 Material Balance Area....13

4.3 Access Controls....13

4.3.1 Material Access....13
4.3.2 Personnel Access....14
4.3.3 Data Access....14
4.3.4 Equipment Access....14

4.4 Material Surveillance....14

4.4.1 Detection/Assessment....15
4.4.1.1 Tamper Indicating Devices....15
4.4.1.2 Periodic Administrative Checks....15

5. Materials Accountability....16

5.1 Accounting System....16

5.1.1 System for Nuclear Material Accountability....16

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

5.1.2 Nuclear Materials Management and Safeguards System (NMMSS) Reporting....16

5.2 Physical Inventory Plan....17
5.2.1 Conducting the Tritium Physical Inventory....17
5.2.2 Conducting the Source (and Other Nuclear Material) Physical Inventory....17
5.2.3 Deuterium Inventory....17
5.2.4 Verification of the Physical Inventory....18
5.2.5 Special Inventories....18
5.2.6 Inventory Verification/Confirmation Measurements for SNM....18

5.3 Measurements and Measurement Controls....18
5.3.1 Liquid Scintillation....19
5.3.2 Ion Chamber....19

5.4 Material Transfers....19
5.4.1 External Transfers....19
5.4.1.1 Authorization for External Transfers of Nuclear Materials....19
5.4.1.2 External Transfer Documentation....20
5.4.1.3 Measurements and Transfer Checks for External Transfers....20
5.4.2 Transfers Within the Material Balance Area....20

5.5 Material Control Indicators....21
5.5.1.1 Shipper/Receiver Evaluations....21
5.5.1.2 Inventory Difference Evaluation....21
5.5.1.3 Evaluation of Other Inventory Adjustments....21

6. Performance Requirements and Internal Program Assessments....21

6.1 Tamper Indicating Devices (TID's)....22

6.2 Accounting Records....22

6.3 Internal Program Assessment....22

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

1. Introduction

1.1 Purpose

This plan describes the elements of the Princeton University Plasma Physics Laboratory (PPPL) nuclear materials control and accountability system for nuclear materials in the custody of PPPL. PPPL management is committed to assure that nuclear materials utilized at PPPL will be properly controlled, inventoried and accounted for as required by DOE Order 5633.3B.

The objective of the Material Control and Accountability (MC&A) program is to provide a basis for planning, implementing and evaluating an information and control system with associated checks and balances sufficient to detect and assist in the prevention of the unauthorized use and removal of nuclear materials from the facility or its authorized locations.

1.2 Scope

The requirements in the plan apply to employees who are involved in the handling, processing, measuring, shipping, receiving, transferring, or inventory of nuclear materials. Nuclear materials are materials designated in DOE Order 5633.3B as nuclear materials. Presently, these materials are: depleted uranium, enriched uranium, americium-241, americium-243, curium, berkelium, californium, all plutonium isotopes, lithium-6, uranium-233, normal uranium, neptunium-237, deuterium, tritium, and thorium.

1.3 Overview

The PPPL nuclear materials safeguards system uses the DOE graded safeguards approach to provide protection based on the risks associated with the types and quantities of nuclear material posing the greatest possible threat for use in an explosive device. With only very small quantities of plutonium and uranium on site, along with other accountable source material, PPPL uses an integrated system of physical protection, materials accounting, and material control measures consistent with the strategic and monetary importance of it's inventory.

1.4 Issuance and Approval

This manual is issued by the Safeguards Manager of the ES&H and Infrastructure Department. It will be reviewed and/or revised on a two-year basis by the Nuclear Material Control and Accountability group. Procedures issued for compliance with MC&A will also be reviewed and/or revised biennially as well.

1.5 References

1. DOE Order 232.1A, Occurrence Reporting and Processing of Operations Information.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

2. DOE Order 5633.3B, Control and Accountability of Nuclear Materials.
3. DOE M 474.1-2, Manual for Nuclear Materials Management and Safeguards System Reporting and Data Submission.
4. DOE Order 470.1, Safeguards and Security Program.
5. DOE Order 471.1, Unclassified Controlled Nuclear Information.
6. DOE Order 5660.1B, Management of Nuclear Materials.
7. PPPL Plan EQP-004, Institutional Quality Assurance Plan.
8. PPPL HP-OP Procedures governing Radioactive Materials
9. PPPL HP-MC Procedure governing Material Control and Accountability.
10. PPPL Procedure QA-002, PPPL Audit/Surveillance Program.
11. PPPL ES&HD 5008, Section 5029, Environment, Safety, and Health Manual, *Safety Review of Procurements.*

1.6 Definitions

Apparent Loss: The inability to physically locate or otherwise account for: (a) any identifiable or discrete item (e.g., batch, lot, or piece) containing nuclear material; b) A nuclear material inventory difference in which the book inventory is larger than the physical inventory by an amount in excess of the established alarm limit; c) An unexplained significant Shipper/Receiver difference.

Approved Seal: A Safeguard Seal that has been approved for use by the DOE Operations Office (DOE Order 5633.3B).

Attractiveness Level: Various categorizations of Special Nuclear Material types and compositions which reflect the difficulty of processing and handling required to convert material to a nuclear explosive device.

Beginning Inventory: The quantity of nuclear materials on hand at the beginning of an accounting period.

Diversion: The unauthorized removal of nuclear material from its approved use or authorized location. The definition of "authorized locations" in the context of diversion of nuclear materials is the responsibility of the cognizant operations office.

DOE/NRC Form 741: "Nuclear Materials Transaction Report," contains information necessary for the documentation of transactions involving nuclear material between facilities, adjustments to inventories, programmatic transfers within facilities, and changes in financial responsibility.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

DOE/NRC Form 742: "Material Balance Report," contains the information necessary for reporting material balances. This form is filled out quarterly to comply with PPPL/DOE contractor's requirements.

Ending Inventory: The quantity of nuclear materials on hand at the end of an accounting period.

Enriched Uranium: Uranium which contains more of the fissionable isotope uranium-235 than the naturally occurring fraction, which is 0.00711 by weight.

External Transfers: Transfers of nuclear materials from one Reporting Identification Symbol (RIS) to another.

Fissile Material: Any material fissionable (splitting of the atom) by thermal (slow) neutrons. The three primary fissile materials are Uranium-233, 235 and Plutonium-239.

Graded Safeguards: A system designed to provide varying degrees of physical protection, accountability, and material control to different types, quantities, physical forms, and chemical and isotopic compositions of nuclear materials consistent with the risks associated with malevolent acts and varying levels of attractiveness and convenience to potential adversaries.

Interlocks: Any entrance or exit which is interlocked in a fail-safe, redundant manner to prevent unauthorized access to the area it encloses.

Inventory (Book): The quantity of nuclear material present at a given time as reflected by accounting records.

Inventory (Physical): The quantity of nuclear material which is determined to be on hand by physically ascertaining its presence using techniques that include sampling, weighing and analysis.

Inventory Difference: The algebraic difference between the nuclear material book inventory and a physical inventory.

Material Balance Area: A Material Balance Area (MBA) is an identifiable physical area under the control of a single custodian where the quantity of nuclear material is represented by a measured value and a material balance can be obtained for inventory or in the event of an emergency.

Nuclear Materials Accountability: Part of the safeguards program encompassing the procedures and systems to: (a) perform nuclear material measurements, (b) verify the location and quantities of nuclear material through physical inventories, (c) maintain records and provide reports, (d) perform data analysis to account for nuclear material and to detect losses, and (e) help investigate and resolve apparent losses of nuclear material.

Nuclear Materials Accounting: The principles and/or practices of systematically recording, reporting, and interpreting nuclear material transaction and physical inventory data.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Nuclear Materials Control: Part of the safeguards program applied to nuclear material and personnel and equipment handling nuclear material to: (1) govern and maintain vigilance over nuclear material activities, (2) promptly verify the existence of nuclear material activities, (3) promptly detect malevolent acts involving nuclear material, and (4) help investigate and resolve apparent losses of nuclear material. Nuclear materials control interfaces with the physical protection part of the safeguards program.

Nuclear Materials Management and Safeguard Systems (NMMSS): The national data base and information support system for nuclear materials controlled by the U.S. Government, created to support national safeguards and management objectives in the domestic and foreign utilization of nuclear resources.

Nuclear Materials Representative: Reports directly to the Safeguards Manager and is responsible for nuclear materials control and accountability.

Nuclear Material Surveys: The comprehensive examination and evaluation of the effectiveness of control and accountability systems for nuclear materials at DOE facilities.

Periodic: A procedure or survey performed at least monthly.

Reporting Identification Symbol (RIS): Unique combinations of three or four letters which are assigned to each reporting facility for the purpose of identification in the nuclear materials management data base.

Safeguards: A collective term that comprises those measures designed to guard against malevolent acts involving material such as source or special nuclear material and to give timely indication of possible malevolent acts or credible assurance that malevolent acts have not occurred. The measures may include, but are not limited to: (1) the maintenance and verification of records of receipt, shipments, and periodic inventories; (2) physical protection; (3) reliability standards for individuals having access to safeguarded materials; (4) inspection of nuclear facilities to provide assurance that malevolent acts have not occurred; (5) physical methods to detect or measure loss of materials and; (6) penal provisions to deter theft, diversion, or sabotage.

Seal Administrator: An individual who has been designated by management to order, control, and issue seals for the facility.

Seal custodian: An individual designated by a material balance area supervisor to have the authority to maintain an inventory of seals and apply those seals to containers.

Sealed Source: Nuclear material which has been packaged to be environmentally and critically safe.

Shipper/Receiver Difference: The difference between the measured quantity of nuclear material stated by the shipper as having been shipped and the measured quantity stated by the receiver as having been received.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Source Material: Only natural Uranium, depleted Uranium, and Thorium are defined as source material; however, for the purposes of this plan, references to source material also includes "other" nuclear materials as defined in DOE Order 5633.3B. These materials are Americium-241, Americium-243, Berkelium, Californium-252, Curium, Deuterium, Lithium-6, Neptunium-237, and Tritium.

Special Nuclear Material (SNM): Plutonium, Uranium enriched in the isotope 233 or in the isotope 235, and any other material which, pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, as amended, has been determined to be special nuclear material, but does not include source material. Also any material artificially enriched by any of the foregoing, but does not include source material.

Transactions: Any recorded change affecting the inventory data base.

1.7 Acronyms and Initialisms

DOE/CH	Department of Energy Chicago Operations Office
GHT	Gas Holding Tank
ID	Inventory Difference
IND	Improvised Nuclear Device
MASIS	Materials Accountability and Source Inventory System
MBA	Material Balance Area
MC&A	Material Control and Accountability
MCD	Materiel Control Division
MIP	Material-in-process
NIST	National Institute of Standards and Technology
NMC	Nuclear Material Custodian
NMMSS	Nuclear Materials Management and Safeguards System
NMR	Nuclear Materials Representative
NOL	Normal Operating Losses
PG	Princeton Group (DOE)
PBX-M	Princeton Beta Experiment - Modified
RIS	Reporting Identification Symbol
RMBA	Routine Material Balance Area
SNM	Special Nuclear Material
TFTR	Tokamak Fusion Test Reactor

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

TID Tamper Indicating Device (Seal)

2. Organization and Administration

2.1 Organizational Structure

The Safeguards Manager in the ES&H and Infrastructure Department is assigned the responsibility for developing a safeguards program to meet the DOE requirements. Figure 2.1 shows the relationship of the ES&H and Infrastructure Department to the PPPL Director and Princeton Group DOE Office (PG).

The Safeguards Manager shall be a senior member of the Health Physics Branch and is responsible for the coordination of the Material Control and Accountability Program. The Nuclear Materials Representative (NMR) is responsible for nuclear materials reporting and reports directly to the Safeguards Manager.

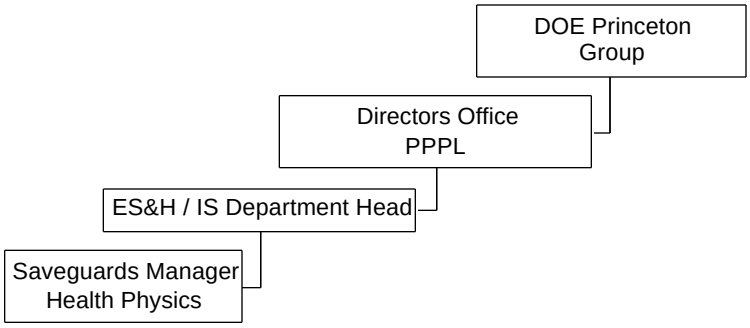
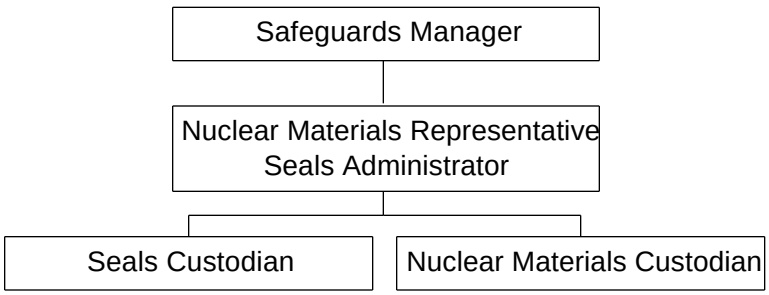


Figure 2.1

The Material Control and Accountability (MC&A) group, which is administered by the Nuclear Materials Representative, is responsible for assuring the implementation and maintenance of a graded material control and accountability system to ensure compliance with the DOE Orders. The MC&A group maintains a computerized system of accountability and the source documents that are applicable to material control and accountability. Figure 2.2 shows the structure of the MC&A group.



Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Figure 2.2

2.2 Responsibilities and Authorities

2.2.1 DOE/CH Division of Safeguards and Security

Assures each contractor and sub-contractor under their jurisdiction who may use or possess designated nuclear materials is required by contract to develop and maintain written current procedures for safeguards control and accountability of nuclear materials.

Assures PPPL is audited biennially for their Material Control and Accountability Program.

2.2.2 DOE Princeton Group

Ensures corrective actions required as a result of nuclear material and/or security surveys are implemented and other responsible Heads of PPPL Field Organizations are promptly notified of the implementing action.

2.2.3 Director of Princeton Plasma Physics Laboratory

Provides sufficient resources to support professional, administrative, technical, and clerical staffing requirements, equipment and materials, logistics support, and training and development for the material control and accountability program at PPPL.

2.2.4 Department Head, ES&H and Infrastructure Support

Ensures personnel performing MC&A functions are trained and/or qualified to perform their duties and responsibilities, and are knowledgeable of requirements and procedures related to the functions at PPPL. The department head has the authority to suspend any activity which is not in compliance with laboratory MC&A policies and procedures.

2.2.5 Safeguards Manager

The Safeguards Manager is responsible for assuring the development of a safeguards program that meets the DOE requirements and communicates with the DOE concerning safeguards issues. Additional responsibilities include testing and evaluating the MC&A system, preparing program planning documentation, and reviewing inventory differences.

The Safeguards Manager also designates a Nuclear Materials Representative, who is responsible for nuclear materials accounting and reporting to DOE/CH for proper data submission to NMMSS.

2.2.6 Nuclear Materials Representative

The Nuclear Materials Representative (NMR) is responsible for implementing and maintaining a graded material control and accountability system to ensure compliance with DOE orders and directives. The NMR is responsible for nuclear materials reporting and data submission to the Nuclear Materials Management and Safeguards System. The

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

NMR has functional authority for nuclear material custodians and is responsible for determining the training required for being a nuclear material custodian. The NMR has responsibility to review requisitions for SNM and other DOE accountable nuclear materials to ensure documentation required by DOE are prepared and reported.

2.2.7 Nuclear Materials Custodian

The nuclear material custodian (NMC) is responsible for protecting, controlling, and accounting for the nuclear material in his/her Material Balance Area (MBA). The custodian is responsible for following approved procedures for physical protection, conducting physical inventories, performing administrative checks as required, documenting transfers, and ensuring persons receiving material from the MBA are authorized to receive it. The custodian is responsible for providing the required documentation to the Material Control and Accountability (MC&A) group on a timely basis. The custodian is also expected to maintain an auditable file of transaction records and administrative check logs for a period prescribed by the MC&A group.

2.2.8 Seals Custodians

The Seals Custodian is responsible for applying safeguard seals (or tamper-indicating devices) to containers and enclosures; witnessing the loading and unloading of containers of nuclear materials; verifying the integrity of applied seals; and storing issued and unused seals in a locked repository as specified in PPPL's *Safeguard Seal Procedure*.

2.2.9 Health Physics Branch

The Health Physics Branch is responsible for the monitoring of nuclear material shipments for any contamination levels that may exist. In addition, the Health Physics Branch is also responsible for the preparation of areas requiring line breaks for transfers of tritium to assure minimal contamination.

2.2.10 Materiel Control Division

The Materiel Control Division is responsible to insure the legality of the accountable nuclear materials receipt. Upon receipt, the MCD is also responsible for notification of the Health Physics Branch, as well as the MC&A group that nuclear material has arrived on site.

2.3 PPPL Communications Information

Reporting Identification Symbol (RIS):	CCA
Field Office:	Chicago Operations Office, RIS: CAA
Area Office:	Princeton Area Office
Contractor Name:	Princeton University Plasma Physics Laboratory

Safeguard Manager:	*George Ascione*
Telephone:	609-243-2513

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

NM Representative: *Catherine Saville*
Telephone: 609-243-2528

NM Representative: *George Ascione*
Alternate

NM Custodian: *Carl Tilson*
Telephone: 609-243-2315

Mailing Address: Princeton University
Plasma Physics Laboratory
James Forrestal Campus
P.O. Box 451
Princeton, NJ 08543

3. Nuclear Material Attractiveness and Categorization

3.1 Background

Nuclear materials are defined as the nuclides designated in the Atomic Energy Act of 1954 and other nuclides designated by the Secretary of Energy. Nuclides may be added or deleted by the Secretary. Nuclear materials are comprised of three major subgroups: source materials, special nuclear materials (SNM), and other nuclear materials. Materials considered source materials are: thorium, depleted uranium, normal uranium, and certain uranium or thorium ores. Materials considered SNM are: plutonium, uranium-233, enriched uranium, or materials enriched by these materials. Materials considered other nuclear materials are: americium, berkelium, californium, curium, deuterium, lithium-6, neptunium, and tritium.

These materials are ranked based on their usefulness in constructing a weapon or improvised nuclear device (IND). The attractiveness of a material relates to the ease at which the material can be converted to a weapon or IND, with attractiveness level A being assembled weapons, etc. to level E being material most difficult to convert. The amount of material, combined with its attractiveness level, is used to determine the material category.

3.2 Classification of Nuclear Materials at PPPL

PPPL's inventory of nuclear materials consists of tritium, and an assortment of other materials in source quantities. Because of the low quantities and forms of nuclear materials on site, PPPL's inventory falls under Category IV, Attractiveness Level E (Level E being the least attractive material/quantity for diversion, on a scale ranging from A to E). Table 3.1 summarizes Category IV nuclear materials and the associated Attractiveness Levels for each material form. Quantities of these nuclear materials must remain within the ranges stated in Table 3.1 for PPPL's inventory to remain as a Category IV inventory.

The reportable quantity units for various nuclear materials are summarized in Table 3.2. For purposes of material transfers and inventories at PPPL, amounts greater than or equal to one-half of a reportable unit are rounded to the larger whole reportable unit value (e.g., for Pu $\geq$ 0.5 g would be rounded to 1.0 g).

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

4. Material Control

Nuclear material at PPPL is contained and surveyed through the use of physical protection features including leak tight system enclosures, protection areas, closed circuit television, alarms, and tamper indicating devices. In addition, there are various administrative safeguards procedures; for example, locked rooms, and periodic administrative checks to support the containment and surveillance of nuclear materials.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Category IV Nuclear Materials	Attractiveness Level	PU/U233	U-235
Pure Products **Pits, major components, buttons, ingots, recastable metal, directly convertible materials.**	B	<0.2 kgs	<0.4 kgs
High-Grade Materials **Carbides, oxides, solutions (≥25g/l), nitrates, etc., fuel elements and assemblies, alloys and mixtures, UF_4 or UF_6 (≥50% enriched).**	C	<0.4 kgs	<2 kgs
Low Grade Materials **Solutions (1 to 25g/l), process residues requiring extensive reprocessing, moderately irradiated material, PU238 (except waste), UF_4 or UF_6 (≥20% < 50% enriched).**	D	<3 kgs	<8 kgs
All Other Materials **Highly irradiated forms, solutions (≤1 g/l), uranium containing < 20% U-235 (any form any quantity).**	E	* Reportable quantities are Category IV regardless of amount.	* Reportable quantities are Category IV regardless of amount.

Category IV Nuclear Materials	Attractiveness Level	Tritium
Weapons or test components containing reportable quantities of tritium.	E	zero (Category III if <0)
Deuterium-tritium mixtures, or metal tritides that can be easily decomposed to tritium gas.	E	containing <50 grams of tritium (isotope) with a tritium isotopic fraction of <20%. (Category III if otherwise)
All other reportable quantities, isotopic fractions, types, and forms of tritium.	E	All other reportable quantities.

TABLE 3.1

4.1 Facility Overview

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951. The long-range goal of the U.S. Magnetic Fusion Energy Research Program is to develop and demonstrate the practical application of fusion power as an alternate energy source.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

Material Classification & Reporting Values	*Other Nuclear Materials*	*SNM*	*Source*
Depleted Uranium			Kilogram
Enriched Uranium		Gram	
Plutonium - 242		Gram	
Americium - 241	Gram		
Americium - 243	Gram		
Curium	Gram		
Californium - 252	Microgram		
Plutonium -239 - 241		Gram	
Lithium - 6	Kilogram		
Uranium - 233		Gram	
Normal Uranium			Kilogram
Neptunium - 237	Gram		
Berkelium	Microgram		
Plutonium - 238		Gram/Tenth	
Deuterium	Kilogram/Tenth		
Tritium	Gram/Hundredth		
Thorium			Kilogram

Table 3.2

4.1.1 Facility Description

The Princeton Plasma Physics Laboratory is located at the C- and D-sites of the James Forrestal Research Campus of Princeton University. The location is in central New Jersey within Middlesex County. The site is surrounded by a modest forest, open grass areas, and a small brook (Bee Brook) running next to its eastern boundary (Attachment 1).

4.1.2 General Plant Security

PPPL is divided into two basic geographical areas. The primary operational area of PPPL (C-site) is an open, tree lined facility area with a primary manned guard post. The secondary site (D-site), contains the TFTR Project area and the NSTX Project area. It is

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

protected by an inner safety fence. Access to D-site is controlled using card access for pedestrian gates and vehicle access gates.

4.1.3 Personnel Access Requirements

Employees entering PPPL C-site must be identified by their Princeton University Plasma Physics Laboratory identification badge. Official visitors, vendors, and other off-site representatives must stop at the main security gate at the entrance to C-site and provide the required identification for issuance of an appropriate security visitor's badge.

Access to various controlled facilities throughout C- and D- sites is managed through the use of the identification badge which has magnetic card reading capabilities.

4.2 Material Containment

PPPL's material containment policy is based on graded safeguards principles and the strategic and monetary value of the material. As stated previously, PPPL's inventory of nuclear material falls under Category IV, attractiveness level E. Containment of these nuclear materials at PPPL are provided by a single Material Balance Area (MBA).

4.2.1 Material Balance Area

A Material Balance Area (MBA) is an identifiable physical area under the control of a single custodian where the quantity of nuclear material is represented by a measured value and a material balance can be obtained for inventory or in the event of an emergency. PPPL has a single MBA defined as the Routine MBA (RMBA), which includes all areas of the site where radioactive materials and deuterium are used and stored.

4.3 Access Controls

The access control program for nuclear materials and the nuclear material accounting system data are designed to ensure that nuclear materials are not diverted or stolen and that data are not falsified in order to cover up a theft or diversion or provide credibility to a hoax. The access control program consists of four elements: material access, personnel access, data access, and equipment access.

4.3.1 Material Access

Nuclear materials are under the control of a Nuclear Materials Custodian (NMC) who is responsible for managing and tracking nuclear material within the Material Balance Area (MBA). The RMBA has a designated storage area under the control of a Nuclear Materials Custodian from the Health Physics Branch. Storage and access of nuclear materials within this MBA are controlled following the Health Physics operating procedure for *Control and Use of Radioactive Sources.* These materials require NMC verification that an individual is properly trained and authorized before access is granted. Authorization for receipt and

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

shipment of radioactive materials including tritium, must be obtained from the Health Physics Branch in accordance with approved PPPL procedures.

4.3.2 Personnel Access

The personnel access controls at PPPL are generally under the jurisdiction of the Security Unit of the Emergency Preparedness Division and, in addition, are under the jurisdiction of the D-Site Shift Supervisor for specified areas of D-Site. The access control program has the following levels:

- PPPL has defined physical barriers for controlling ingress or egress to and from the site by use of personnel badge checks.

- The locations included in the Material Balance Area (MBA) are situated within areas having controlled access and are designed to detect and prevent unauthorized removal of nuclear materials and tritium.

- The material control and protection of nuclear materials within the operating facilities is the responsibility of the material user. Nuclear materials are required to be stored in a secure location.

4.3.3 Data Access

Access to the MC&A accountability database is password protected and controlled by the Nuclear Materials Representative. Approval by the Safeguards Manager is required for any individual outside the MC&A group wanting access to the data. Changes to data on the database must be made by a member of the MC&A group based on data input from the nuclear material custodian. Only members of the MC&A group have been authorized to make changes. The process for the administration of passwords and characterization can be found in applicable, internal Health Physics MC&A procedures.

4.3.4 Equipment Access

The PPPL accountability measurement system is also protected with personnel access controls to protect the integrity of the instruments and the accountability data. The measurement equipment is protected in restricted cardreader access rooms, and is only operated by trained and qualified personnel.

4.4 Material Surveillance

The material surveillance program implemented at PPPL is a combination of material control, accountability, and physical security measures. These elements provide assurance that unauthorized activities are detected and include the following:

- Authorization for access to and movement of nuclear material

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

- Tamper indicating devices
- Periodic administrative checks (tritium items only)
- Locked rooms
- Inventory procedures (all nuclear materials)
- Project procedures for line breaks

These surveillance elements provide a defense in-depth; that is, a graded safeguards system that requires response actions and resolution of anomalies. In addition, Health Physics Alarms are evaluated along with other material control indicators to ensure that the nuclear material is still under control, i.e., when a room monitor or waste stream monitor indicates contamination above background.

4.4.1 Detection/Assessment

The following elements comprise the detection assessment program which is designed to detect the unauthorized removal of or tampering with nuclear materials. Along with the material surveillance and containment elements listed above, these components provide a sufficient safeguards program for PPPL's nuclear material.

1. Tamper Indicating Devices
2. Periodic Administrative Checks

4.4.1.1 Tamper Indicating Devices

PPPL's policy is to utilize TIDs on nuclear material containers where practical. The requirements and procedures for utilizing TIDs are described in applicable HP MC&A procedures, which is administered by the MC&A group. Acquisition, tracking, and destruction of TIDs is performed and/or monitored by the Seal Administrator. A 100% inventory and inspection of new seals received from the manufacturer is performed and documented verifying serial numbers. Seals are issued to trained Seal Custodians on an as needed basis. The Seal Custodian must sign the Master Seal Log for each seal received. Seals, whether in the possession of the Seal Administrator or Seal Custodian, are stored in a locked repository. PPPL utilizes two types of seals, e-cup and vinyl. Seal application and removal requires two individuals, a Seal Custodian and a witness, to perform the loading or unloading of a nuclear material containment. Only an approved Seal Custodian, or a member of the MC&A group, is authorized to apply or remove a seal.

4.4.1.2 Periodic Administrative Checks

PPPL's administrative check program is conducted on tritium items only as prescribed by internal HP MC&A procedures. Results of administrative checks are forwarded to the MC&A group for review and retention.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

5. Materials Accountability

Accountability for nuclear materials as stated in DOE 5633.3B consists of five areas: accounting systems, inventories, measurements and measurement control, material transfers, and material control indicators. The functions of these areas are performed and maintained using the graded safeguards approach, providing accountability of the materials on site to the extent required by the categories and attractiveness levels of the material type.

5.1 Accounting System

Nuclear materials are controlled using an accounting system that is maintained by the MC&A group. The PPPL's accountability system is designed to provide tracking of nuclear materials inventories, documenting internal and external transactions where applicable, producing reports, and isolating inventory losses. The accountability system is designed around the guidance and requirements contained in DOE Order 5633.3B.

5.1.1 System for Nuclear Material Accountability

The Materials Accountability and Source Inventory System (MASIS) is a database and spreadsheet combination used to process all transactions affecting PPPL's nuclear materials inventory and to maintain a current site inventory listing.

Due to the small, fairly static inventory of nuclear materials making up PPPL's inventory, a single record entry system is used for documenting MC&A accountable material and its relevant information (location, composition and weight values). Transaction information for updating MASIS, i.e., location and disposition, is provided by the Nuclear Materials Custodian and material users. Double-entry accounting is utilized only, if feasible, for material processing. In addition, DOE/NRC 741 Forms are maintained as records for accountability purposes and provide an audit trail for all transactions affecting the MASIS database and nuclear material inventory.

Integrity of the MASIS is ensured two ways. The databases are copied for backup purposes after each update. Backups of the system including the programs and database are also retained to allow for the databases to be reset if a problem is detected. Password administration and characterization are also performed and are addressed in MC&A procedures.

5.1.2 Nuclear Materials Management and Safeguards System (NMMSS) Reporting

The transfer of nuclear materials from one facility to another is documented on the DOE/NRC Form 741, *Nuclear Materials Transaction Report*, which is prepared and distributed to the receiver and the cognizant field office(s). The 741 document is transmitted preferably on the day of the transfer, or within one workday after the actual shipment has occurred. This form is also used to document any adjustments to the inventory, i.e., inventory differences, normal operational losses. Details regarding completion and

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

distribution of DOE/NRC Form 741 for PPPL are specified in HP MC&A procedure for material transfers.

A quarterly *Material Balance Report*, DOE/NRC Form 742, summarizes the transactions for a specified nuclear material within a three month period. A single material balance report is prepared for each nuclear material, documenting receipts, removals and any other transaction affecting the inventory during the time frame.

5.2 Physical Inventory Plan

Physical inventories are required annually for Category IV nuclear materials. The nuclear materials inventory at PPPL consists of three types of materials: (1) tritium, which was used during the operation of the Tokamak Fusion Test Reactor (TFTR); (2) small quantities of SNM, source, and other nuclear materials, in source form; and (3) deuterium. The Nuclear Materials Custodian and the Health Physics Branch of the ES&H and Infrastructure Department have overall responsibility for ensuring a physical inventory of these materials are performed as required. Any discrepancies are investigated and resolved by the Health Physics Branch and the Nuclear Materials Custodian.

5.2.1 Conducting the Tritium Physical Inventory

A physical inventory of tritium consists of verification of sealed tritium containers and determination of the tritium quantities within the gas holding tanks (GHTs), bubbler cleanup systems, and disposable molecular sieve beds (DMSBs). The storage location, container serial number, TID number, and TID integrity are verified for each sealed tritium container.

Holdup values were determined during the operation of the TFTR for the process piping and torus using Inventory by Difference. Tritium was measured at the entry points of the piping system and measured again as it accumulated in the GHTs from recoveries of the tritium clean-up system, tritium vault clean-up system, and tritium storage and delivery glove box. The difference between the entry measurements and the gas holding tank readings were considered the holdup. Now that TFTR is shutdown, holdup inventory is what remains of the tritium inventory. The holdup value in not measurable and therefore cannot be part of the physical inventory process.

5.2.2 Conducting the Source (and Other Nuclear Material) Physical Inventory

The wall-to-wall inventory concept is used when conducting the source inventory, starting at one logical place in the MBA and working through to a logical stopping place, following applicable Health Physics procedures. All serial numbers of the items within the boundaries of the MBA are located, verified, and listed on an inventory sheet.

5.2.3 Deuterium Inventory

An accounting of deuterium is performed on a quarterly basis. Individuals using deuterium are contacted and requested to provide a current item count of deuterium cylinders in their

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

possession. Responses are returned to the Nuclear Materials Representative in time to submit the quarterly Material Balance Report.

5.2.4 Verification of the Physical Inventory

To ensure that items have been accounted for, a comparison is made between the book inventory within the Materials Accountability and Source Inventory System (MASIS) database and the physical inventory sheets. Discrepancies due to misplaced or missing items are investigated by the Nuclear Materials Custodian. Reporting and data discrepancies are handled by the Nuclear Materials Representative. Adjustments are submitted to DOE/Chicago Safeguards and Security Division on a DOE/NRC Form 741 with the following quarterly Material Balance Report (DOE/NRC Form 742) reflecting the current physical inventory.

5.2.5 Special Inventories

Special Inventories are required when certain events take place that warrant an accounting for nuclear materials. These include emergencies that may physically involve nuclear materials, routine disassembly of facilities, changes in custodial responsibilities, requests by PPPL management personnel or the DOE, etc. Three inventory actions can be implemented: Item Count, Partial Inventory, and 100% Inventory. The three actions are defined as follows:

1. An Item Count is a verification of the Material Transfer Logs maintained by the Nuclear Materials Custodian which identifies the location of nuclear materials within a Material Balance Area.
2. A Partial Inventory is the serial number verification of containers in a specified material type. This includes reconciliation with the computer database.
3. A 100% Inventory is the serial number verification of nuclear containers on PPPL's inventory. This includes reconciliation with the computer database, transfer activities, and computing inventory differences.

5.2.6 Inventory Verification/Confirmation Measurements for SNM

Special Nuclear Materials (SNM) at PPPL are in the form of sealed sources in small quantities. Performance of a verification/confirmation measurement on these materials would require destruction of these sources, and are therefore, not amenable to measurement. Shipper measurements are accepted as PPPL inventory values, using half life times to calculate the on going activity of the sources.

5.3 Measurements and Measurement Controls

Measurement and measurement control programs are required for facilities processing nuclear materials. Currently PPPL is not processing any nuclear material. Both tritium and deuterium in bulk gas form were used during operation of the TFTR and are part of the site's

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

inventory. The tritium remaining in the TFTR as holdup is not measurable, however tritium removed from the TFTR systems is measured using liquid scintillation. Additionally, any tritium escaping to the Gas Holding Tanks is measured using Ion Chambers. Deuterium is accepted at the shipper's value and tracked by cylinder instead of a measurement program due to it's low vulnerability.

5.3.1 Liquid Scintillation

The primary technique for measurement of tritium collected in a liquid medium (bubbler systems) is liquid scintillation. Samples of tritium contaminated water are analyzed using Packard liquid scintillation counters. The counters are calibrated every 24 hours with a tritium standard and a carbon 14 standard. The instruments are maintained on a daily basis using tritium and standard background control charts. PPPL's laboratory is certified by the EPA for tritium analysis in water. Blind studies of tritium in water are analyzed twice a year and are provided by both the EPA, and the DOE's EML laboratory.

5.3.2 Ion Chamber

The primary instrument for measurement of the inventory collected onto containers for shipment off-site are the gas holding tank (GHT) ion chambers. They reside in sample loops off of the gas holding tanks, where the specific activity measured in a sample loop is normalized to the GHT pressure, volume, and gas species. This data is then used to calculate the activity in a gas holding tank before and after any tritium transfer operation. Calibration of these instruments are performed following applicable PPPL procedures. Measurement data for the tritium systems are collected by the Tritium Operators following applicable TFTR procedures. Collection of this data requires in-depth knowledge of the TFTR tritium systems, and therefore, is only performed by certified Tritium Operators. These individuals undergo an extensive training program as documented in applicable PPPL procedures.

5.4 Material Transfers

Tracking of DOE Recordable Nuclear Materials as they enter and exit PPPL property and the necessary reporting information required by DOE Orders in the 5633 series pertaining to Nuclear Material Control and Accountability is documented under Health Physics, *MC&A Material Transfer Procedure.*

5.4.1 External Transfers

5.4.1.1 Authorization for External Transfers of Nuclear Materials

Authorization to ship nuclear material from PPPL to another facility is obtained by the Nuclear Materials Representative before any nuclear material is transferred from PPPL. Authorization consists of verification that the receiving facility can accept the material and

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

completion of Nuclear Material Control & Accountability requirements the receiving facility may have on transfers of nuclear materials prior to shipment.

When nuclear materials are shipped to PPPL, an authorization code is issued by the Nuclear Materials Representative (NMR) before another facility may ship any nuclear material to PPPL. The NMR verifies that the acceptance of the material will not place PPPL in a nuclear material inventory category higher than IV. Upon verification, the NMR issues an authorization code number for the shipment to the shipping facility's Material Control and Accountability group.

5.4.1.2 External Transfer Documentation

Transfers of nuclear material between PPPL and other facilities are documented on a DOE/NRC Form 741, *Nuclear Material Transaction Report* , and should be prepared and distributed within 24 hours or on the first workday after the transfer should it occur on a nonworkday.

5.4.1.3 Measurements and Transfer Checks for External Transfers

Due to PPPL's inventory consisting solely of category IV quantities of nuclear materials and the shutdown of TFTR's tritium processing operations, no material currently being used at PPPL requires accountability measurements. Historically, all nuclear materials received at PPPL other than tritium have been in source form or of low vulnerability and have not required accountability measurements. With the shutdown of TFTR, no bulk gas tritium has been received on site requiring accountability measurements. The authorization process should detect any future off-normal requests for nuclear materials that may require accountability measures. An evaluation of the requirements for any such requests will be performed at that time.

Transfer Checks are performed upon receipt of any nuclear material. A transfer check consists of verification that the shipping container information matches the information provided by the shipping facility, both on the shipping and authorization documentation. In addition, a Seals Custodian verifies the seal integrity and identification on the containers in the shipment. Internal Health Physics procedures describe the actions to be taken if a discrepancy occurs during a transfer check of incoming and outgoing shipments.

5.4.2 Transfers Within the Material Balance Area

Nuclear materials within an MBA are under the control of a designated NMC and transfers of nuclear material within an MBA are monitored and documented by the NMC as part of the material control program. All nuclear material transfers are controlled by the Nuclear Material Custodian and the Health Physics Branch of the ES&H and Infrastructure Department.

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

5.5 Material Control Indicators

PPPL maintains material control indicators through the Nuclear Materials Accountability programs to ensure that losses and unauthorized removals of nuclear materials are detected. When material control indicators are outside of established limits, an immediate investigation is initiated by the Safeguards Manager. The material control indicators are shipper/receiver evaluations, inventory difference evaluations, and evaluations of other types of inventory adjustments as specified in the "DOE 5633.3B Guide of Implementation Instructions for Nuclear Materials Management and Safeguards System Reporting and Data Submission."

5.5.1.1 Shipper/Receiver Evaluations

The MC&A group reviews shipping and receiving data to ensure that nuclear material transfers are valid. If a transfer check reports abnormalities with the packaging, the MC&A group will review the data and put a hold on the material until the discrepancy is resolved. Unresolved shipper/receiver differences will be reported to the DOE Field Office for resolution. Reviews will be documented and reports prepared as required by DOE Orders. A shipper/receiver difference is defined to be significant when it involves a discrepancy in the number of items shipped, regardless of the quantity of nuclear materials.

5.5.1.2 Inventory Difference Evaluation

Inventory Differences (IDs) are based on item counts and item identification. The guidelines and procedures for evaluations and investigations of IDs are described in PPPL internal procedures and follow the guidance of applicable DOE orders.

5.5.1.3 Evaluation of Other Inventory Adjustments

Other inventory adjustments such as normal operational losses/measured discards, rounding bias and radioactive decay are evaluated as the need arises. Historically, deuterium and tritium are the only nuclear materials used at PPPL where the material is lost through normal operations. NOLs for deuterium use known cylinder quantities, and the number of cylinders used determines the NOL. Tritium packaged for shipment to a waste facility is declared a NOL. Approval for annual tritium waste disposal is required by DOE/CH. Rounding biases occur primarily from converting curies to grams during the tritium accounting process. Supporting documentation is retained for adjustments due to rounding bias. Decays are calculated using the decay factors found in the implementation guide for DOE Order 5633.3B and are reported on the DOE/NRC Form 742 *Material Balance Report* when an accumulated decay amount reaches a reportable quantity.

6. Performance Requirements and Internal Program Assessments

Verification of nuclear material control and accountability procedures and practices are required to demonstrate that material controls are effective. Inventories classified as Category IV require annual performance testing of tamper-indicating devices (TIDs) and

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.

accounting records. An internal assessment of the MC&A program is required at least biennially for Category IV inventory facilities and should be conducted midway between scheduled DOE/CH MC&A surveys.

6.1 Tamper Indicating Devices (TID's)

Tamper-indicating devices or seals are used to ensure nuclear materials stored in containers have not been violated without physically verifying the nuclear material itself. For verification of their performance as loss control devices, seals are checked for proper application and integrity. The location and identity of seals are also verified against the Master Seal Log ensuring seals are properly traced. The PPPL seal program is documented in PPPL's *Material Control and Accountability Safeguard Seal Procedure.*

6.2 Accounting Records

Accounting records provide documentation of the nuclear material inventory, and as a loss control device, must reflect the location of nuclear materials on site. Verification of the nuclear material inventory is performed by a random comparison of the accounting records to the actual physical inventory.

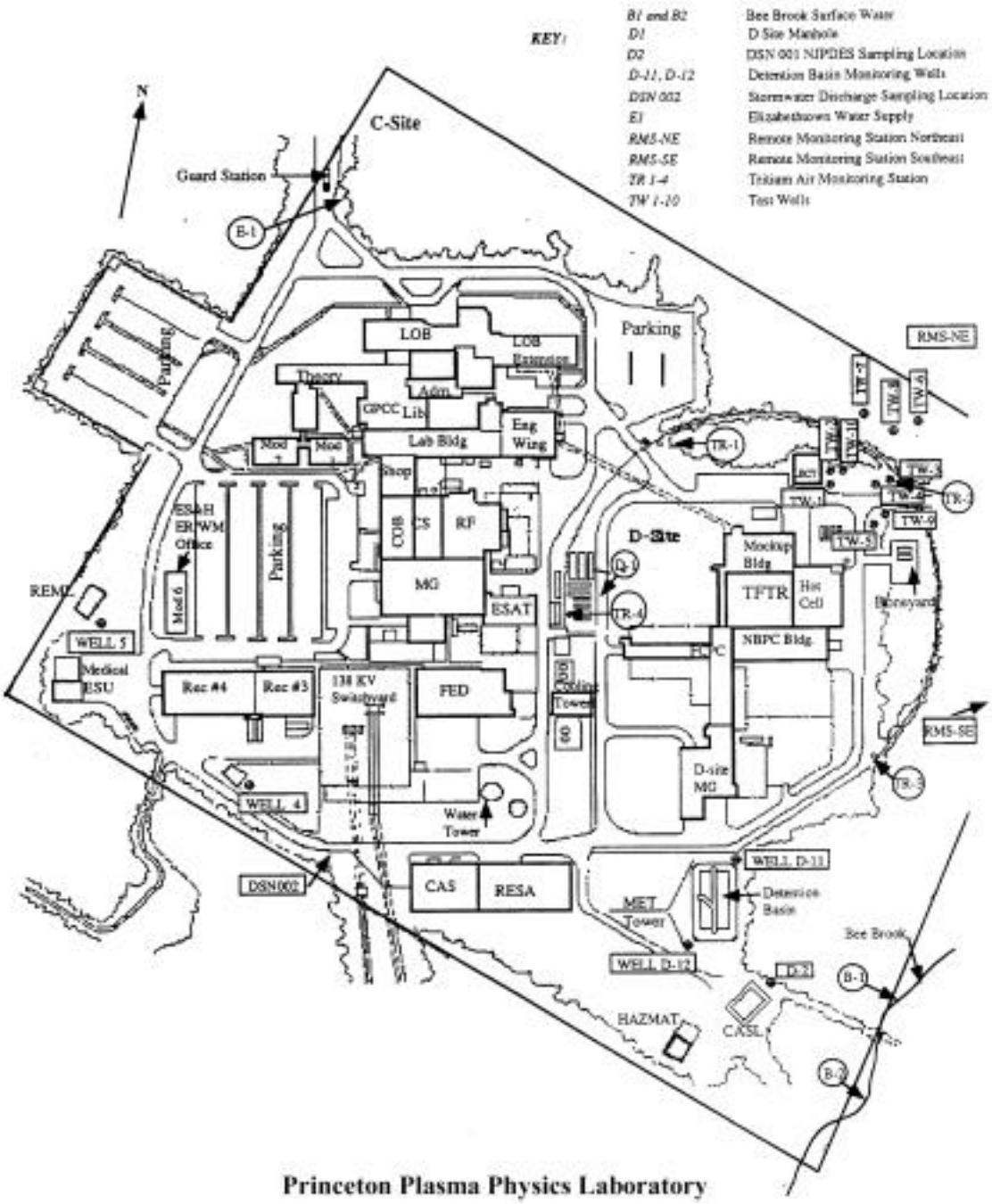
6.3 Internal Program Assessment

Internal assessments of the MC&A program at PPPL are performed by the QA/R Division as prescribed in applicable PPPL procedures. This assessment is required biennially and is scheduled through the QA/R Division or by request of the Safeguards Manager. The results are documented, reviewed, and upon request, a copy forwarded to DOE/CH SSD.

Attachments

1. PPPL Site Map

Printed copies of this document are considered UNCONTROLLED / Information Only copies.
The official document is at http://www-local.pppl.gov/pppl/services/support_services/#ProcdsPubs
The ES&H and Infrastructure Support Department maintains the signed original.



Princeton Plasma Physics Laboratory

Site Map

Attachment 1