

EA-0813; Environmental Assessment and (FONSI) The Tokamak Fusion Test Reactor Decontamination and Decommissioning Project and The Tokamak Physics Experiment at the PPPL

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Environmental Assessment

The Tokamak Fusion Test Reactor
Decontamination and Decommissioning Project

and

The Tokamak Physics Experiment

at the

Princeton Plasma Physics Laboratory

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EXECUTIVE SUMMARY

The environmental impacts of two distinct but interrelated projects proposed by the Department of Energy (DOE) are evaluated in this Environmental Assessment (EA) pursuant to regulations for implementing the procedural provisions of the National Environmental Policy Act of 1969 (NEPA) (Pub. L 91-190.42 U.S.C. 4321 et seq.) (40 CFR 1500) and DOE NEPA Implementing Procedures (10 CFR 1021). Actions are connected if they cannot or will not proceed unless other actions are taken previously or simultaneously (40 CFR 1508.25(a)(1)(ii)). In order for the Tokamak Physics Experiment (TPX) Project to occur at Princeton Plasma Physics Laboratory (PPPL), it is first necessary to decontaminate, decommission (D&D) and modify the existing Tokamak Fusion Test Reactor (TFTR). Since the TPX cannot proceed without TFTR D&D, the actions are connected for the purposes of NEPA. Also, the DOE committed in the EA for the TFTR Deuterium-Tritium Modification and Operations (DOE/EA-0566) to a full analysis of the environmental impacts of D&D of the TFTR in a subsequent document. The TPX was proposed subsequently to the TFTR Deuterium-Tritium modifications and operations.

Construction of the TFTR began at PPPL in 1978, and it achieved first plasma in late 1982. It is currently in the final stage of its intended lifetime, during which the TFTR is being operated with deuterium-tritium (D-T) fuel in the last year of planned operation. At the conclusion of D-T operations the TFTR must be decontaminated and decommissioned as required by DOE Order 5820.2A "Radioactive Waste Management."

The TPX is a new fusion energy initiative designed to make significant contributions toward achieving the goals of the U.S. fusion energy program. The action consists of construction and operation of the TPX at PPPL. As proposed, the TPX would use the TFTR Test Cell Complex (Test Cell, Test Cell Basement, and Hot Cell) and other TFTR systems and facilities, and the new experiment would be primarily located inside the existing TFTR Test Cell.

Proposed Actions and Alternatives

The proposed TFTR D&D action would provide for the dismantlement and removal of all TFTR contaminated and activated systems within the TFTR Test Cell Complex. Waste resulting from D&D operations would be packaged and disposed in an appropriate manner. Alternatives to the proposed action include: no action and delayed action. The proposed action and delayed D&D alternatives would require the new construction of a radioactive waste storage building (RWSB) and a new stormwater detention cell.

The proposed TPX action would consist of the design, construction and operation of the TPX within the existing TFTR facility at PPPL. The proposed action would utilize existing PPPL utilities and TFTR support systems. New facility construction would include: TFTR Test Cell modifications; cryogenic equipment building; electrical substation; and miscellaneous tank yards. All new construction would take place on existing open space within the D-site area at PPPL. The TPX would be designed to operate for approximately 10 years. The TPX conceptual design is based on operation with deuterium fuel, but it does not exclude potential operation with tritium fuel.

A matrix showing the proposed actions and alternatives considered in the EA is given in Table ES-1. The TFTR D&D no-action alternative and the TFTR D&D delayed alternative could not be coupled with the proposed TPX because of the prompt need for the TFTR test cell complex by the proposed TPX action. Similarly, the TPX no-action alternative and Oak Ridge Reservation (ORR) site alternative would be unreasonable to couple with the proposed TFTR D&D project because neither of these TPX alternatives would require the prompt use of the TFTR test cell complex, as required by the project schedule for the proposed TPX.

Table ES-1. Proposed actions and alternatives matrix.

TFTR D&D	TPX		
	Proposed	No action	ORR site
Proposed	x	Unreasonable Combination	Unreasonable Combination
No Action	Impossible Combination	x	x
Delayed	Impossible	x	x

Combination

x= Combinations of alternatives discussed in EA.

Affected Environment

The proposed TFTR D&D and TPX projects would both be located at PPPL, which is located along Route 1 in central New Jersey, in Middlesex County, approximately 5 km (3 mi) east of the main campus of Princeton University. The estimated 1990 resident population within a 16 km (10 mi) distance of the site was approximately 446,000 and is projected to grow to 499,000 by the year 2010. Community services in the area are well-developed. The local utilities would be able to accommodate the demand of the proposed action.

The overall air quality in the PPPL area generally meets State and Federal limits. The atmospheric stability in the PPPL area is predominantly neutral to stable. The site lies within a zone of low to moderate historic earthquake activity. The water table at PPPL varies from 0 to 8 m (0 to 26 ft) below the land surface. Surface drainage from PPPL is to Bee Brook. Generally, this brook water is of good quality. Aquatic plant growth in Bee Brook is minimal, and the aquatic fauna are typical of those occurring in small woodland streams. Use of the area inside the TFTR facility boundary (i.e., the fenced area surrounding the TFTR facility) by wildlife is very limited. The area inside the TFTR fence is typical of an industrial complex with buildings, paved and gravel roadways, and storage areas and has very little habitat suitable for wildlife. A mature wooded area surrounds the PPPL site. No threatened or endangered species, as identified by State or Federal agencies, have been identified at the PPPL site. There are no historical, architectural, or known archaeological resources located in either project area.

Environmental quality and monitoring programs would be maintained and improved to ensure laboratory compliance with all applicable Federal, State, and local regulations, standards, and guidelines. Analyses of environmental samples conducted thus far have shown that PPPL fusion research activities have not resulted in environmental concentrations of tritium or any other radionuclides at levels higher than background levels.

The alternative site evaluated for the TPX is at the ORR which is considered to be a reasonable alternate site. This judgement is based on the existence at ORR of recent fusion machine

operating experience, a fusion technology group, and support infrastructure such as roads, buildings,

utilities, electrical power, and fire protection. Other sites not having these features are not considered

practical or feasible from a common sense, technical, and economic standpoint. The ORR TPX site is located in the southeast corner of the Oak Ridge Gaseous Diffusion Plant (ORGDP) site about 40 km (25 mi) west of Knoxville, TN. Some existing buildings at the ORGDP could be used as well as new facilities that could be constructed. The affected environment at the alternative site is typical of

that for a large industrial manufacturing type facility, and could accommodate the siting of the TPX.

Environmental Impacts of the Proposed Actions

Nonradiological Impacts

Activities associated with the TFTR D&D and the TPX would not present any long-term or adverse nonradiological impacts to the public or the environment at the PPPL site. The TFTR D&D project would result in minor impacts, consisting primarily of commitment of a small area of onsite

land for the RWSB and a second storm water detention cell. The TPX project would also require some onsite land for new construction of the cryogenic facilities, tank yards, and electrical substation.

Other TPX and TFTR D&D nonradiological impacts would be temporary.

Radiological Impacts from Normal Operations

Potential radiological impacts of normal TFTR D&D operations and TPX operations at the TFTR Test Cell Complex would be minor and would not represent potential impacts greater than those from current PPPL operations. Both projects have adopted a design objective dose of 10 mrem

per year as a maximum allowable individual dose to any member of the public. The TFTR D&D project would result in minor releases of activated metal and perhaps tritium to the atmosphere and

sewer system. The maximum calculated individual public dose from TFTR D&D activities is 2.3 mrem per year, and the increased probability of health effects from this dose would be 1.1×10^{-6}

(1.1 chances in 1,000,000). Occupational doses would not exceed the PPPL administrative limit of 1,000 mrem per year. The small radioactive releases to the environment, as well as exposures and dose equivalents to the public and workers, would be well below acceptable DOE, State, and Federal

standards.

Radiological impacts from the TPX would be potentially higher than for TFTR D&D, but would not exceed current impacts from PPPL operations. The TPX design is based on the use of

deuterium fuel, but does not preclude the potential future use of tritium fuel. For potential environmental, safety, and health radiological impact considerations, the tritium fuel operations that would bound deuterium operations were considered, analyzed, and included in the environmental assessment. Atmospheric releases of tritium and activation products constitute the potential sources of radiological exposure to members of the public. For tritium operations the projected atmospheric releases would result in an annual effective dose equivalent of 4.6 mrem and an increased probability of health effects of 2.3×10^{-6} (2.3 chances in 1,000,000) to a hypothetical maximally-exposed individual at the site boundary. During deuterium operations, the maximum atmospheric releases would result in a site boundary dose of 1.2 mrem and an increased probability of health effects of 6.0×10^{-7} (6 chances in 10,000,000). These conservatively calculated effective dose equivalents are less than the most restrictive limit for public doses caused by airborne releases (the EPA limit of 10 mrem/year). Direct radiation from the TPX would be mitigated with shielding to keep the total effective dose equivalent from all sources at the site boundary within the project design objective of less than or equal to 10 mrem/year. This design objective effective dose equivalent is well below the DOE limit of 100 mrem/year to members of the public from routine DOE operations. The maximum annual individual dose to a member of the public from TPX operations (9.6 mrem from 1 year of tritium operations) would result in an increased probability of health effects of 4.8×10^{-6} per year (4.8 chances in 1,000,000).

Normal TPX operations would result in total estimated collective effective dose equivalents of 7.5 person-rem per year and 24 person-rem per year to the projected population within the 80 km (50 mi) radius area surrounding PPPL during deuterium and tritium operations, respectively. This amounts to an average effective dose equivalent of less than 0.002 mrem per year to each individual in the assessment area. A collective effective dose equivalent of 7.5 person-rem per year would result in less than 1 (0.004) health effect in the exposed population. A collective effective dose equivalent of 24 person-rem per year represents less than 0.002% of the collective effective dose equivalent from natural background radiation in the area (exclusive of radon) and would result in less than 1 (0.012) health effect in the exposed population. The maximum annual public collective dose from TPX operations (24 person-rem per year from 1 year of tritium operations) would result in less than 1 (0.01) health effect.

The maximum cumulative dose to an individual at the PPPL site boundary resulting from 10 years of TPX operation at PPPL would be 48 mrem. Based on this cumulative dose the cumulative

probability of health effects to a member of the public from 10 years of normal TPX operations at PPPL is 2.4×10^{-5} (2.4 chances in 100,000). The cumulative population dose resulting from 10 years of TPX operation at PPPL would be 91 person-rem. Based on this cumulative population dose 4.6×10^{-2} fatal cancers would be expected in the population surrounding PPPL from 10 years of normal TPX operations.

Occupational doses to workers during normal TPX operations would result from direct radiation and small releases of tritium and activated gases. Operational procedures, administrative controls and monitoring by environment, safety and health personnel would ensure that occupational doses are kept below regulatory limits and as low as reasonably achievable.

Radiological Impacts from Accidents

Accidental releases of radioactive material could result from (a) natural phenomena (e.g., earthquakes), (b) accidents with external origin (e.g., airplane crashes), (c) shipping accidents (i.e., accidents involving the transportation of radioactive material), and (d) operational occurrences (e.g., tritium leaks). All TFTR and TPX confinement boundaries would be capable of maintaining integrity for design basis seismic events, and therefore a release due to a natural phenomena event is extremely unlikely.

Accidents with external origins and transportation accidents involving small quantities of radioactive material would present little risk to the public and the environment. Transportation accidents involving larger quantities of radioactive material, for example tritium, could occur; however, the accidental release of significant quantities of radionuclides has a very low probability because of the demonstrated integrity of the approved containers that would be used.

Operational occurrences that could result in the accidental release of tritium, activated gases, or solids consist primarily of component failures and human errors. Releases associated with these occurrences would be limited by component inventories. The calculated individual doses from all accident scenarios are all below the DOE siting guideline limit of 25 rem. Health effects resulting from the collective doses would represent a negligible increase in the total number of expected health effects in the exposed population from all natural background radiation doses. The largest potential dose to the public from TFTR D&D accident scenarios, including Beyond Design Basis Accidents (BDBAs), is 390 mrem to a maximally exposed member of the public. The largest potential doses to the public from TPX accidents are summarized in Table ES-2.

Table ES-2. Largest potential public radiological impacts from TPX accidents.

Release	Individual		Population	
	Dose (mrem)	Probability of health effects	Collective dose (person-rem)	Total expected health effects
Tritium	390	2×10^{-4}	1,710	8.6×10^{-1}
Activated Gases	1	5.0×10^{-7}	negligible	-
Activated Solids	5	2.5×10^{-6}	2.2	1.1×10^{-3}

Accidental occupational radiological doses could result from inadvertent exposures to tritium, activated gases, or activated structures. Access control systems, systems for monitoring and alarm, and emergency response procedures for onsite personnel would keep accidental occupational exposures for both TFTR D&D and TPX below regulatory limits.

Environmental Impacts of TPX Decontamination and Decommissioning

After TPX operation has ended, D&D of the facility would be required. The general procedure would be to disassemble the activated and contaminated TPX components and structures and dispose of them in an appropriate DOE waste disposal facility, consistent with decisions arising from the upcoming DOE Programmatic Environmental Impact Statement on Environmental Restoration and Waste Management. All such material would qualify as low-level radioactive waste.

Decontamination and decommissioning activities would not result in any adverse environmental impacts. The methods and procedures would be typical of those currently used during D&D of other small nuclear facilities. Activated and contaminated components and structures would be disposed of in an appropriate DOE waste disposal facility.

Combined Cumulative and Long Term Impacts of the TFTR D&D and TPX Projects.

No incremental impacts of either project when added to impacts of other projects proposed at

PPPL, would be significant. Similarly, no adverse long-term impacts would result from either project, separately or combined. Beneficial long term impacts from the connected projects include timely accomplishment of required D&D activities, beneficial reuse of a major investment in equipment and personnel at PPPL, and continued progress in fusion energy research. Finally, reusing the TFTR facility, and thereby not requiring more extensive expenditures of resources, represents a long term benefit by allowing such resources to be conserved or used elsewhere.

Environmental Impacts of Alternatives to the Proposed Actions

The no-action and delayed action TFTR D&D alternatives would merely postpone the estimated environmental impacts of the proposed TFTR D&D to some future date.

The no-action alternative to the proposed TPX action would result in the absence of impacts from the TPX. The alternative of siting the TPX at ORR would have minimal impacts (equivalent to the proposed action), and would avoid cumulative effects due to the proposed TFTR D&D project. However, siting the TPX at ORR would result in financial and resource losses from not using the major investment in facility, equipment and personnel at PPPL.

Summary

Implementation of the proposed actions would not result in any significant adverse environmental impacts, and would provide the capability to acquire essential fusion energy research and development data. Implementation of the TFTR D&D project would allow the timely use of the TFTR facilities by the TPX project, as well as carrying out required D&D activities. Research data that would be obtained from the TPX are essential to the successful and efficient design of future fusion reactors, and would contribute to the timely accomplishment of achieving useful power from fusion energy. Additionally, implementation of the proposed actions would provide a positive effect in regard to DOE waste minimization/pollution prevention policies due to reuse of TFTR facilities and equipment.

ACRONYMS

ALARA	as low as reasonably achievable
BDBA	beyond design basis accidents
BPX	Burning Plasma Experiment

CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D-D	deuterium-deuterium
D-T	deuterium-tritium
D&D	decontamination and decommissioning
DOE	Department of Energy
DOT	Department of Transportation
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EPA	Environmental Protection Agency
ES&H	Environment, Safety and Health
FCPC	Field Coil Power Conversion
FSAR	Final Safety Analysis Report
H-D	hydrogen-deuterium
HEPA	high-efficiency particulate air (filter)
HTO	tritiated water
HVAC	heating, ventilation, and air conditioning
LOAEL	lowest-observed-adverse-effect-level
LWC	lost work cases
MeV	million electron volts
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NJAC	New Jersey Administrative Code
NJDEPE	New Jersey Department of Environmental Protection and Energy
NJPDES	New Jersey Pollution Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORR	Oak Ridge Reservation
PBX-M	Princeton Beta Experiment - Modification
PF	poloidal field
PPPL	Princeton Plasma Physics Laboratory
PSAR	Preliminary Safety Analysis Report
PSE&G	Public Service Electric and Gas
RCRA	Resource Conservation and Recovery Act
RF	radio-frequency
RWSB	Radioactive Waste Storage Building
SAR	Safety Analysis Report
TF	toroidal field
TFTR	Tokamak Fusion Test Reactor
TPS	Tritium Purification System

TPX Tokamak Physics Experiment
TSCA Toxic Substances Control Act

Glossary of Radiological Terms

activation Process of producing a radioactive material by bombardment with neutrons, protons or other nuclear particles.

activity The amount of radioactive material. It is a measure of the transformation rate of radioactive nuclei at a given time. The customary unit of activity, the curie, is 3.7×10^{10} nuclear transformations per second.

airborne radioactivity Radioactive material in any chemical or physical form that is present in ambient air, above natural background.

as low as reasonably achievable (ALARA) An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels as low as is reasonable, taking into account social, technical, economic, practical and public policy considerations.

background dose The radiation dose that individuals received from background radiation.

background radiation Radiation from natural sources, such as cosmic sources; naturally occurring radioactive materials in soil, and global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct or special nuclear materials, or from medical exposures.

collective dose The dose to a population, measured in person-rem calculated by summing the dose to each person in the group of interest. For example, if 12 workers each receive 1 rem, then the collective dose is 12 person-rem.

curie A unit of radioactivity (see activity).

decommissioning Actions taken to reduce the potential health and safety impacts of DOE contaminated facilities, including activities to stabilize, reduce, or remove radioactive materials or to demolish the facilities.

decontamination The removal of radioactive contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

dose The amount of energy deposited in body tissue due to radiation exposure.

effective dose equivalent The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

health effect For this EA, fatal cancers.

individual dose The radiological dose received by an individual over a stated time period.

ionizing radiation Any radiation displacing electrons from atoms or molecules, thereby producing ions. Examples: alpha, beta, gamma radiation; short-wave ultraviolet light. Ionizing radiation may cause severe skin or tissue damage

isotope An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses (e.g., N-13 and N-16 are isotopes of nitrogen).

lowest-observed-adverse-effect level (LOAEL) The lowest dose of a chemical in a study or group of studies which produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

low-level waste Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "by-product material" as defined by DOE Order 5820.2A.

neutron Uncharged subatomic particle capable of producing ionization in matter by collision with charged particles.

nuclide An atomic nucleus specified by its atomic weight, atomic number, and energy state.

occupational dose The dose received by a person during employment in which the person's assigned duties involve exposure to radiation and to radioactive material. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

person rem/year The collective dose for a group of individuals over the period of a year.

radioactivity A natural and spontaneous process by which the unstable atoms of an element emit or

radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.

radiological dose See dose.

radionuclide A radioactive nuclide.

rem Unit of dose equivalent. (1 rem = 0.01 sievert.)

whole body dose The sum of external exposures and the committed internal exposures from inhaled, absorbed, or ingested radionuclides.

SCIENTIFIC NOTATION

When dealing with very large or very small numbers, the conventional notation is awkward and cumbersome. Writing 0.000000000000001, for example, is undesirable, as is calling this number "a millionth of a billionth." To overcome this problem, a notation system in general use throughout

the scientific community has been employed in this document for very large and very small numbers.

This system would indicate the above number as 1×10^{-15} or 1E-15. This notation can then be converted back to the original number by moving the decimal point according to the power of ten that

is indicated. If the power of ten is positive, for example, the decimal is moved to the right the

number of places indicated by the power. If the power of ten is negative, the decimal is moved to the

left the number of places indicated by the power. Examples of positive and negative powers of ten

follow:

$$1.25 \times 10^5 = 1.25\text{E}+5 = 125,000$$

$$1.25 \times 10^{-4} = 1.25\text{E}-4 = 0.000125$$

Prefixes are often added to units (such as curies or grams) to indicate the magnitude of the value. Common prefixes, their values, and their abbreviations are as follows:

Prefix	Power	Value	Symbol
--------	-------	-------	--------

tera	10 ¹²	1,000,000,000,000	T
giga	10 ⁹	1,000,000,000	G
mega	10 ⁶	1,000,000	M
kilo	10 ³	1,000	k
centi	10 ⁻²	0.01	c
milli	10 ⁻³	0.001	m
micro	10 ⁻⁶	0.000001	u
nano	10 ⁻⁹	0.000000001	n
pico	10 ⁻¹²	0.000000000001	p
femto	10 ⁻¹⁵	0.000000000000001	f

Thus, 1 kilogram (kg) = 10³ grams = 1,000 grams, and 1 microcurie (uCi) = 10⁻⁶ curie = 0.000001 curie.

1.0 PURPOSE AND NEED FOR THE PROPOSED ACTIONS

If the U.S. is to meet the energy needs of the future, it is essential that new technologies emerge to compensate for dwindling supplies of fossil fuels and the eventual depletion of fissionable uranium used in present-day nuclear reactors. Fusion energy has the potential to become a major source of energy for the future. Power from fusion energy would provide a substantially reduced environmental impact as compared with other forms of energy generation. Since fusion utilizes no fossil fuels, there would be no release of chemical combustion products to the atmosphere. Additionally, there are no fission products formed to present handling and disposal problems, and runaway fuel reactions are impossible due to the small amounts of deuterium and tritium present. The purpose of the TPX Project is to support the development of the physics and technology to extend tokamak operation into the continuously operating (steady-state) regime, and to demonstrate advances in fundamental tokamak performance. The purpose of TFTR D&D is to ensure compliance with DOE Order 5820.2A "Radioactive Waste Management" and to remove environmental and health hazards posed by the TFTR in a non-operational mode.

There are two proposed actions evaluated in this environmental assessment (EA). The actions are related because one must take place before the other can proceed. The proposed actions assessed in this EA are: the decontamination and decommissioning (D&D) of the Tokamak Fusion Test Reactor (TFTR); to be followed by the construction and operation of the Tokamak Physics Experiment (TPX). Both of these proposed actions would take place primarily within the TFTR Test Cell Complex at the Princeton Plasma Physics Laboratory (PPPL). The TFTR is located on "D-site" at the James Forrestal Campus of Princeton University in Plainsboro Township, Middlesex County, New Jersey, and is operated by PPPL under contract with the United States Department of Energy (DOE).

1.1 TFTR D&D Project

The description of the proposed TFTR D&D Project in the following sections is based on the Preliminary Decontamination and Decommissioning Plan (PPPL 1993a). The TFTR will cease operations in the near future, leaving in place radioactive materials and waste that must be handled in an environmentally safe manner. The purpose of the TFTR D&D is to minimize risks to human health and the environment by ensuring the safe handling, storage, and disposal of activated materials and radioactive waste. Furthermore, the D&D is necessary to maintain compliance with DOE Order 5820.2A "Radioactive Waste Management."

1.1.1 Purpose

The purposes of the proposed TFTR D&D project are to dismantle and remove the TFTR and other components from the TFTR Test Cell Complex (Test Cell, Test Cell Basement and Hot Cell) (due to TFTR project end-of-life), and to render the Test Cell Complex suitable for use by the proposed TPX Project.

Normally, D&D would be delayed longer than the currently planned safe shutdown period to allow for additional radioactive decay; however the relatively low level of radioactivity makes the D&D at this time feasible and appropriately safe. During the safe shutdown period, removal of tritium inventories, nonradioactive and salvageable components would occur. The purpose of the TFTR D&D Project is not to remove the TFTR Test Cell Complex from active use, because it is planned to be used by the proposed TPX Project. Therefore, final D&D of the facility is not included in this TFTR D&D Project.

1.1.2 Need

Operation of the TFTR with deuterium-tritium (D-T) fuel is currently planned to cease in October 1994. Following the D-T operations, D&D of the TFTR is required by DOE Order 5820.2A, "Radioactive Waste Management" (DOE 1988).

The TFTR D&D Project is needed to provide early availability of the TFTR Test Cell Complex for the proposed TPX Project. This would allow the TPX Project to make use of most support facilities and systems which already exist at the TFTR site at considerable cost savings to the DOE.

1.2 TPX Project

The proposed TPX Project consists of the construction and operation of the next major experiment in the DOE Magnetic Fusion Energy Development Strategy.

1.2.1 Purpose

The purpose of the proposed TPX Project is to develop the scientific basis for a compact and continuously operating tokamak fusion reactor. The TPX would contribute towards achieving a major goal of the U.S. fusion energy program, the development of a tokamak demonstration reactor. The specific mission of the TPX is to develop the physics and technology needed to extend tokamak operation into the continuously operating (steady-state) regime, and to demonstrate advances in fundamental tokamak performance. The TPX Project would provide the capability to acquire essential fusion energy research and development data, as described in PPPL (1993b).

1.2.2 Need

The current state of fusion technology lacks certain information regarding magnetic confinement systems leading to the development of a continuously operating (steady-state) regime. The TPX is designed to acquire data in this area. These data would contribute to the development of fusion reactors as a potential alternative energy source.

1.3 Scope of Document

The purpose of this EA is to evaluate and consider environmental impacts of the two proposed actions. The actions are being evaluated in the same EA because the preferred alternative for the TPX Project cannot proceed at PPPL until the TFTR facility has been decontaminated and modified, and therefore the projects are connected as defined in 10 CFR 1021 (DOE 1992b). Alternatives for each action are also evaluated, including the relationships of possible alternatives for each action.

This EA has been prepared in accordance with the provisions of the National Environmental Policy Act (NEPA) of 1969 (as amended) as implemented in the NEPA regulations of the Council on Environmental Quality (CEQ 1992), DOE Order 5440.1E (DOE 1992a), and 10 CFR 1021 (DOE 1992b).

Section 2 of this EA describes the proposed actions and alternatives, Section 3 characterizes the local environments at PPPL and at the alternative TPX site as they now exist, and Section 4 describes the expected environmental effects of the proposed actions and alternatives. The environmental analyses presented in this EA are based on design data available at the time of writing.

Where empirical data are lacking, simplifying conservative assumptions are used to provide a reasonable upper bound for expected impacts. Environmental effects are presented for the maximum expected construction activities, operating parameters, and credible accidents postulated for both the TFTR D&D Project and the TPX Project. A summary comparing the environmental effects of the

proposed actions and alternatives is provided in Section 5. Applicable environmental regulations are discussed in Sections 6 and 7.

1.4 Local Community Relations Program

Through its ongoing Community Outreach Program, PPPL will take steps to inform local governmental bodies and the public of the preparation of this document and to provide for appropriate public participation (e.g., public information meetings on these projects). This effort will assist DOE in complying with provisions of NEPA requirements pertaining to public involvement. The main objectives of PPPL's Community Outreach Program are to increase public understanding of the PPPL fusion program, to address local concerns on environmental and safety aspects of PPPL operations, and to establish and maintain close communication links with local government and community groups. The program achieves these objectives in part by having speakers address various community groups. Additionally, an average of 5000 visitors attend laboratory open houses, special tours, and educational programs at PPPL each year. The possibility of a new fusion project being built at PPPL has been discussed at many of these functions.

1.5 References

- CEQ, 1992. "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," Code of Federal Regulations, Title 40, Parts 1500-1508. January.
- DOE, 1988. "Radioactive Waste Management," Order 5820.2A, U.S. Department of Energy, Washington, D.C., September 26, 1988.
- DOE, 1992a. "National Environmental Policy Act Compliance Program," Order 5440.1E, U.S. Department of Energy, Washington, D.C., November 10, 1992.
- DOE, 1992b. 10 CFR 1021, 57 FR 15144 - 15158, "National Environmental Policy Act Implementing Procedures," April 24, 1992.
- PPPL, 1993a. Preliminary Decontamination and Decommissioning Plan for the Tokamak Fusion Test Reactor, D&D 00012DDOC, Princeton Plasma Physics Laboratory, Princeton, New Jersey, February 1993.
- PPPL 1993b. "TPX Conceptual Design Overview," TPX Conceptual Design Review, March 29 - April 1, 1993, 91-930323PPPL/WReiersen-01.

2.0 DESCRIPTION OF THE PROPOSED ACTIONS AND ALTERNATIVES

2.1 TFTR D&D Project

The TFTR D&D Project description is based on the fact that the TFTR has been operated with D-T plasmas, which would result in the production of approximately 2×10^{21} neutrons during its operating lifetime. Moderate TFTR Test Cell radiation levels would exist, and precautionary measures for worker occupation of the Test Cell would be required. Dismantling and removal of nonradioactive and low activation components in areas such as the Test Cell Basement and the Hot Cell, as part of the D-T program, would start immediately after the conclusion of TFTR operations.

Safe shutdown of the TFTR (see Figure 2-1), which would be accomplished by TFTR Project personnel, would include removal of all tritium storage inventories from the site; operational cleanup

of all TFTR support systems; de-energization and lockout of all systems that are to be dismantled;

completion and documentation of a radiological survey and radionuclide characterization; and visual

inspection and evaluation to identify potential problem areas. The radionuclide characterization would

provide the information required to finalize the planning of the D&D activities, and would have a direct bearing upon the scheduling and manpower requirements, particularly those related to personnel

exposure. The operational plan for TFTR D&D is based on existing decommissioning technology as available from the nuclear fission industry. After a cool down and safe shutdown period of about 2

years, TFTR Test Cell D&D work could be accomplished in approximately 1.5 years, and the TFTR Test Cell Complex would be available for the TPX Project approximately 3.5 years after termination

of TFTR D-T operations. Additional information regarding the TFTR Test Cell Complex and TFTR D-T operations is in DOE (1992).

2.1.1 Proposed TFTR D&D Action

The proposed action would consist of the D&D of TFTR. Some existing systems and components within the Test Cell Complex (such as four of the five Neutral Beam Lines; Torus Vacuum Pumping System and Residual Gas Analyzer; Diagnostics; Cryogenic System; and the Ion Cyclotron Resonant Frequency Heating System) are expected to be used either partially or completely

by the TPX Project, and would be decontaminated and stored. The TFTR system components that would require D&D include at a minimum: piping, instrumentation and electronics; umbrella structure and upper poloidal field (PF) magnet coils; vertical columns and lintels; toroidal field (TF)

magnet coils and vacuum vessel; inner support structure and PF coils; and lower PF coils.

Figure 2-1. TFTR D&D and TPX Project schedules.

The decontamination and dismantling techniques which will be used during the TFTR D&D are presently being evaluated. However the preliminary D&D plan for TFTR (PPPL 1993a) provided the baseline methods (e.g., vacuum vessel welder-cutter, arc saw and plasma arc torch) which were used to evaluate the potential health and environmental impacts in this EA.

In addition to "hands-on" work, the use of semi-remote and remote operations would be required for some of the D&D work. All dismantling work from the TF coils inward to the center of the machine would likely be performed with remotely operable tooling and equipment. Temporary confinement control structures utilizing plastic sheet supported upon metal framing and equipped with exhaust fans, ducts, and HEPA filters would be provided at each D&D work station. These structures would be used to limit the spread of contamination within the Test Cell during D&D. The existing TFTR Test Cell Complex would provide additional confinement and would minimize the release of particulate contamination from D&D operations to the environment. Because of the use of confinement control structures and the existing Test Cell filter system, any particulate emissions from the TFTR D&D Project would consist primarily of extremely small (sub-micron) sized particles, which would be only a small fraction (less than 1%) of the total airborne particles produced (Newton et al. 1987). Based on an estimate of the mass of material to be cut and the radioactivity levels at the time of cutting (PPPL 1993a), and a conservative estimate of the fraction that becomes airborne, an estimated 0.86 Ci/yr of residual activation products would be released out the stack during TFTR D&D operations (Commander 1994). Also small amounts of tritium, no greater than 500 Ci, could be released over a 1-year period to the TFTR Test Cell during the vacuum vessel sectioning. The tritium would be vented to the atmosphere through the TFTR Test Cell HVAC system and TFTR Facility stack.

Any radioactive liquids produced during D&D operations would be pumped to liquid effluent collection tanks. Disposal of these liquids would be as described in Section 2.2.1.4.

Waste resulting from D&D operations would consist of: stainless steel and aluminum structures; piping and components; copper coils and power bus bars; graphite tiles; resin beds; filters; solidified radioactive liquids; anti-contamination materials; and concrete rubble. These wastes would be packaged into Department of Transportation (DOT) approved containers and transported to a designated DOE disposal site, assumed at this time to be the DOE Hanford site in Richland, Washington. Approximately 950 m³ (33,500 ft³) of waste weighing approximately 2270 metric tonnes (2,500 tons) would be disposed. It would consist entirely of Class A low-level waste, according

to

the criteria of 10 CFR Part 61 (NRC 1992). The specific routes for shipment of D&D waste to the Hanford site are being evaluated and will be discussed with the State of New Jersey. Possible routes

leaving PPPL may include (1) Route 1 North to Route 287 North to Route 80 West and on to Hanford; or (2) Route 1 South to Route 295 South to Route 31 North to Route 78 West into Pennsylvania, northern route (e.g., Route 81) to Route 80 West and on to Hanford. A few of the largest shipments may be transported by rail from the Monmouth Junction spur or from the connection at the Johnson & Johnson facility in New Brunswick to Newark, and then west to Hanford.

The only new permanent building construction during the TFTR D&D Project would be a radioactive waste storage building (RWSB) for temporary storage of pre-packaged radioactive waste. It would be designed to store approximately 1-month's accumulation of radioactive waste awaiting shipment. There would also be space for temporary storage of TFTR components to be used by the TPX Project. This facility would be approximately 560 m² (6,000 ft²) in size, and would be constructed within the existing D-site fence on previously disturbed ground (in the existing boneyard

area) as shown in Figure 2-2. The waste in this building would consist of tritium-contaminated waste

packages and bulk activated material. The facility would also be used by the TPX Project for temporary storage of packaged low-level radioactive material generated during TPX operations.

In addition, it would be necessary to construct a second storm water detention cell to comply

with Delaware and Raritan Canal Commission requirements for the runoff from the planned RWSB and new TPX building construction. The second detention cell would be located west of the existing

detention basin and be of similar size. Other actions would be examined (and performed if found to

be necessary and feasible) to reduce storm water run off from the site (e.g., removal of under-utilized

or unused trailers parked on permeable areas).

Figure 2-2 also shows the wetlands and a 15 m (50 ft) transition zone based upon a detailed wetlands delineation study at PPPL utilizing field reconnaissance techniques (Taylor et al. 1993). No

new construction is planned within the transition zone, and as a result, there will be no impact on

these wetlands.

[Figure 2-2. General PPPL site plan with proposed new construction and wetlands location relative to PPPL facilities.](#)

2.1.2 Alternatives to the Proposed Action

In addition to the alternatives described below, several other activities were considered. These include D&D followed by excessing the TFTR Test Cell for possible future use, and complete D&D with dismantlement of all TFTR facilities. These alternative activities were determined to be unreasonable because they would fail to use and maximize the conservation of existing resources, and would require extensive and time-consuming construction of new facilities at another site in order to meet the DOE fusion program objectives. These alternatives would adversely impact the TPX Project cost and schedule. Therefore these alternatives are not considered further in this EA. Table 2-1 shows a matrix of the alternatives considered in this EA. The no-action and delayed D&D alternatives are evaluated for the TFTR D&D Project, and no-action and ORR site alternatives are evaluated for the TPX Project (see Section 2.2). The other possible alternatives are mentioned but no environmental effects are estimated for them. Section 5 contains a discussion of the environmental effects of the various combinations of alternatives. The TFTR D&D no-action alternative and the TFTR D&D delayed alternative could not be coupled with the proposed TPX Project because of the prompt need for the TFTR test cell complex by the proposed TPX action. Similarly, the TPX no-action alternative and the TPX ORR site alternative would be unreasonable to couple with the proposed TFTR D&D Project because neither of these TPX alternatives would require the prompt use of the TFTR test cell complex, as required by the schedule for the proposed TPX Project.

Table 2-1. Proposed actions and alternatives matrix.

		TPX Project		
TFTR D&D	Proposed	No action	ORR site	
Proposed	x	Unreasonable Combination	Unreasonable Combination	
No Action	Impossible Combination	x	x	
Delayed	Impossible Combination	x	x	

x = Combinations of alternatives discussed in EA.

2.1.2.1 No Action.

A no-action alternative must be evaluated in the EA, according to DOE's NEPA regulation [10 CFR 1021.321(c)]. For the TFTR D&D Project, this EA alternative is assumed to consist of termination of TFTR operations, safe shutdown and an extended period of

protective custody of the TFTR Facility. Therefore, the no-action alternative would involve a minimum scope of activities following completion of D-T operations rather than an absence of any actions. First, safe shutdown activities would be accomplished under the no-action alternative, as described for the proposed action. Following completion of safe shutdown activities, the TFTR facility would be placed in a state of protective custody. This would involve establishing and maintaining adequate radiation monitoring, environmental surveillance, and security procedures to protect public health and safety. The period of protective custody would last until final disposition (D&D) of the facility.

2.1.2.2 Delayed Action.

This alternative would be similar to the proposed action, but would involve a longer delay between safe shutdown activities and commencement of D&D activities. Under this alternative, termination of TFTR operations and the same safe shutdown activities as described for the proposed action would be accomplished. This would be followed by a 2-3 year period of delay, during which the TFTR facility would be in a state of protective custody (mothball status) similar to that described for the no-action alternative. After the delay period, D&D activities (as described for the proposed action) would take place. Therefore, this alternative differs from the proposed action only by the inclusion of a longer radiological decay period before D&D, which would eliminate the timely availability of the TFTR Test Cell Complex for the proposed TPX Project.

2.2 TPX Project

The proposed TPX Project description is based upon the TPX conceptual design. The description assumes that the TFTR D&D Project has been successfully completed. The TPX conceptual design is based on the use of deuterium fuel, but it does not preclude the potential future use of tritium fuel. This section describes both modes of operation.

2.2.1 Proposed TPX Project Action

The proposed action consists of construction and operation of the TPX Project within the TFTR Test Cell Complex at PPPL (see Figure 2-2). Project construction would commence at the PPPL site at the conclusion of the TFTR D&D Project as shown by Figure 2-1. The following existing TFTR facilities would be adapted and used by the TPX Project: TFTR Test Cell Complex; ventilation exhaust vent and intake shafts; mockup building; tritium supply, cleanup, and waste handling area; field coil power conversion building; neutral beam power conversion building (including process cooling water area); motor generator building; radioactive waste systems space; computer and control rooms in the laboratory/office building; data transmission tunnel; office

and

technical support space; and miscellaneous PPPL support facilities. In addition to providing space for

the TPX Project, the TFTR Test Cell Complex would provide shielding (via concrete walls, roof, and

floor), and provide for confinement and handling of tritium-contaminated and radioactive components.

Additional descriptive information regarding the existing TFTR Test Cell and TFTR Facilities is in

DOE (1992).

Existing PPPL utilities that would be used by the TPX Project include: intercommunication system, plant electrical power system, area lighting system, fire and security alarm system, sewage system (connected to a publicly owned treatment works), steam generation and distribution system, water supply and distribution system, and roads and parking areas.

The proposed action also includes the use of existing TFTR support systems that would be modified as necessary: neutral beam lines; pulsed electrical power system; field coil power conversion system; neutral beam power conversion system; instrumentation and control system; tritium receiving, storage, cleanup, and recycling systems; fueling system; heating, ventilation, and air conditioning (HVAC) system; and water cooling systems. Prior to use in the TPX Project, any modified buildings, utilities, and systems would be qualified during preoperational integrated tests.

2.2.1.1 TPX Construction.

The TPX Project construction would be scheduled such that there would be no interference with TFTR operations, and only minimal overlap with TFTR D&D activities. The total estimated cost for construction of the proposed TPX Project is approximately \$500 million (FY-93). Construction of the TPX tokamak and conventional facilities would require approximately 240 worker-years of construction labor, peaking at 150 worker-years and averaging 80 worker-years for each year of the construction period (1997 to 2000). Components of the TPX tokamak would be fabricated offsite by industrial contractors and staged in the TFTR Mockup building at PPPL. Tokamak assemblies would then be moved into the TFTR Test Cell for final assembly.

New conventional facilities construction would include: TFTR Test Cell building modifications, a new Cryogenic Equipment building, tank yards for water cooling and cryogenic tanks and a new electrical substation. The Test Cell building modifications would be internal and would not increase the existing external dimensions of the building. The Cryogenic Equipment building

would be constructed as a standard industrial single-story building, totaling about 1,000 m² (10,800 ft²) in area. The tank yard construction would include approximately 2,130 m² (22,950 ft²)

of new tank yard areas for new gaseous helium tanks, liquid nitrogen storage tanks, water storage tanks, and truck-trailer access. This construction would take place on existing open space within the

D-site Area at PPPL (Figure 2-2). Excavation for new foundation structures would require temporary

stock piling of topsoil at approved locations near the construction activity. The topsoil would be used

for backfill and grading. The electrical substation construction would involve installation of a new

138 kV transmission line between the C-site substation and the new D-site substation (see Figure 2-2).

The new substation would transform 138 kV power to 13.8 kV. The new line from C-site to D-site would be constructed entirely on PPPL property, and would involve stringing new transmission lines

between two existing transmission towers. If available TPX upgrade options described in the TPX General Requirements Document and Section 2.2.1.2 are implemented, the existing incoming utility power line conductor would have to be replaced with a larger size conductor, and one piece of equipment at the existing PPPL substation may have to be replaced by the local utility.

Increased storm water run off due to the new construction would be accommodated by construction of a second storm water detention cell as described in Section 2.1.1.

Standard and required safety precautions would be administered throughout all construction phases. All contractors would be required to adhere to these requirements. PPPL and the Princeton

Area Office of DOE would ensure that all applicable specific DOE requirements and PPPL procedures, as well as other applicable local, State and Federal regulations, would be followed.

2.2.1.2 Operation.

The TPX Project would include construction of a tokamak, which is a toroidal (doughnut-shaped) device for producing controlled nuclear fusion. The fusion reactions that

would occur in the TPX tokamak involve various combinations of hydrogen (H) and two hydrogen isotopes, deuterium (D) and tritium (T), (i.e., H-D, D-D, and D-T reactions). Byproducts of these

fusion reactions include helium nuclei, neutrons, and a net energy release. The fuel must be heated to

high temperatures for the reactions to take place. The fuel is suspended and contained in the tokamak

in a magnetic field and is heated by electrical-current, neutral beam and radio-frequency (RF). This

high temperature fuel is referred to as plasma because the atoms are in an ionized state. The TFTR

Test Cell Complex would provide the TPX tokamak housing and related operational and maintenance

functions. Tritium contamination of plasma facing systems and neutron activation of components are

anticipated inside the Test Cell.

The TPX Project would be scheduled to begin tokamak assembly in 1998, with the first plasma operations in 2000. Plans would be to operate TPX with hydrogen and deuterium plasmas for 10 years. In hydrogen operation, neutron generation would not be significant in terms of neutron activation of components or radiological doses. In deuterium operation, the peak fusion power is not

expected to exceed 140 kW. During long pulse deuterium operation, 2.45 MeV neutrons would be the primary neutrons produced, and annual production of these neutrons would be limited to 6.0×10^{21} neutrons. A smaller number of 14.1 MeV neutrons would be produced from deuterium-tritium (D-T) fusion reactions with tritium produced from the D-D fusion reactions. Production of 14.1 MeV

neutrons during deuterium operation would be approximately 2% of the 2.45 MeV neutron production rate. The level of radiological activation of solids, fluids, and gases depends on both the number of

neutrons and the energy of the neutrons to which the materials are exposed. All potential impacts

from H-D operations are completely bounded by any that may arise from D-D operations.

There is also a project requirement to be able to upgrade the TPX facility to operate with D-T

plasmas for the last year of the planned 10 years of operation. During D-T operation, a fully-formed

deuterium plasma would be developed (requiring up to roughly 1,000 seconds), into which tritium would be injected through a neutral beam injector. Once tritium had been injected, the device would

operate for 2 seconds with a peak fusion power of 15 MW, after which the plasma would be terminated. During the 2 seconds of D-T operation, both 2.45 MeV neutrons and 14.1 MeV neutrons would be produced, from D-D and D-T fusion reactions, respectively. Production of 2.45 MeV neutrons during D-T operation would be approximately 1% of the 14.1 MeV neutron production rate. Operation of the tokamak would be limited as necessary so that annual neutron production would not

result in exceeding a site boundary dose restriction adopted by the project (see Appendix A). If the

facility were to be upgraded for D-T operation, the D-T phase would be limited to the last year of

TPX operation, if at all.

An operational tritium inventory limit for the TPX Project would be established, if needed, during the design stage, and would be controlled throughout the TPX Project lifetime by means of an

appropriate document approved by DOE. This would limit the total amount of tritium in onsite components of the TPX Project, since those amounts would be included when calculating the total onsite PPPL inventory. For analysis purposes, the tritium quantities projected to be in onsite components for the TFTR D-T Project (DOE 1992) were used as upper bound estimates for the TPX

Project.

Some of the neutrons produced from operation of the TPX tokamak would result in the generation of activated gases, primarily activated nitrogen and argon produced within the Test Cell atmosphere (see Appendix A). During hydrogen operation, neutron activation would be very limited because neutron production would be limited. During the deuterium phase of operation, Ar-41 (with a radiological half life of 1.8 hours) would be the primary air activation product formed. Approximately 140 Ci of Ar-41 would be formed during each year of D-D operations, of which less than half would be released out the TFTR Test Cell Complex vent stack due to radiological decay during exhaust of the Test Cell atmosphere. If the facility is upgraded for a single year of D-T operations, additional air activation products would be produced during operation of the tokamak, because of the increased number of pulses and higher neutron production rates assumed for D-T operation. Less than 130 Ci per year of N-13 (with a radiological half life of 10 minutes), 150 Ci per year of N-16 (with a radiological half life of 7 seconds), and approximately 600 Ci per year of Ar-41 would be released during D-T operations, in addition to small quantities of other air activation gases (e.g., Cl-40 with a radiological half life of 1.4 minutes) (see Appendix A). The Test Cell shield walls would prevent the production of significant quantities of these radioisotopes outside the Test Cell. Some tritium would also be released to the Test Cell atmosphere during D-D and D-T operations, primarily during maintenance activities when the vacuum vessel may be opened to the Test Cell atmosphere. Tritium would not be used during hydrogen or deuterium operation, however it would be produced from reactions in the plasma during deuterium operation. Annual production of tritium (which is assumed in this EA to be released to the environment through the exhaust stack) has been estimated to be less than 300 Ci per year during D-D operations (Fleming 1993). If a Tritium Purification System (TPS) which could use a cryogenic distillation process to recover and store tritium produced in TPX D-D plasmas (PPPL 1993b) is used, tritium releases to the environment during normal D-D operations would be less than about 1.2 Ci per year (Fleming 1993). Tritium releases have been estimated to be 500 Ci per year during the D-T phase (Bartlit and Jalbert 1988).

The existing incoming 138 kV utility power line that supports PPPL operations would be used in its present configuration to provide power for TPX operations. The TPX electric power demand from the local utility would be different from the loads presently imposed by the existing loads of TFTR and the Princeton Beta Experiment - Modification (PBX-M) at PPPL. The current PPPL base load (about 10 MW) would increase by about a factor of two once TPX operations begin. The peak pulsed power that would be used during initial TPX operation (about 100 MW) is comparable to the

peak pulsed power presently used by PBX-M. The pulse lengths for TPX would be 100-1,000 times longer than for present PPPL experiments. Upgrade options are available for TPX that, at a maximum, would increase the peak pulsed power requirement by about a factor of 2.5. This possible

upgrade demand has been discussed with the local utility, Public Service Electric and Gas (PSE&G 1993). To meet the possible demand, PSE&G may have to replace an electrical component at the PPPL substation, and would have to replace the existing transmission line conductors incoming to PPPL. The line replacement would involve temporarily de-energizing the affected lines, removing the

existing lines and replacing them with new ones [about 3.2 km (2 mi) of line]. The existing transmission towers are capable of supporting the larger size conductor, so no new towers would have

to be constructed (PSE&G 1993). This would be a routine maintenance operation of PSE&G, and is not considered to be extensive work. No problems associated with this work have been identified by

PPPL or PSE&G.

Potential TPX facility upgrades would be for the purpose of improving machine performance and pulse length, none of which would involve new exterior construction or operational impacts. These upgrades are discussed in detail in the TPX General Requirements Document (PPPL 1993c) and include: vacuum pumping system capacity increase; neutral beam power increases; resonant frequency heating capacity increase; power system line capacity upgrade; accommodation of diagnostic upgrades for added data collection and control; and pulse length upgrade for steady state

operation with H and D plasmas (up to 200,000 seconds) and for 2 seconds of operation with a DT plasma.

2.2.1.3 Maintenance.

Provisions for preventative and corrective maintenance have been incorporated into the design of the TPX tokamak and other systems. In general, maintenance to systems located external to the tokamak radiation shielding would be accomplished with hands on operations. Maintenance to systems located internal to the radiation shielding would be accomplished

remotely once material activation exceeds exposure limits imposed by PPPL administrative limits. The TFTR hot cell facility would be used for repair of activated components. Planned outages due to

scheduled maintenance would occur periodically during a run period. Provision would also be provided for glow discharge cleaning for cleaning of plasma facing components and recycle of tritium.

One horizontal port is planned for primary access of the maintenance equipment into the vacuum vessel. Shielding would be integrated into the maintenance systems at the port area to permit

personnel access in the test cell during maintenance operations and during transfer of

contaminated/activated components to the hot cell. Some components attached to the horizontal ports

and subject to neutron streaming could become mildly activated and require special precautions during

maintenance to limit personnel exposure. Examples are diagnostic equipment and the neutral beam torus isolation valve. Maintenance of these components would be handled on a case-by-case basis.

Transfer to and from the vessel of tooling, removed components, and replacement components would be accomplished by a transfer manipulator. Activated or contaminated components removed from the vessel would be placed in a shielded transfer container for transport to the hot cell. Special remote

tools required for maintenance of system components would be provided. The remote maintainability

of equipment likely to require remote maintenance during the life of the machine would be demonstrated on mockups prior to final design.

2.2.1.4 Waste Generation.

Low-level solid radioactive wastes generated during TPX

operations would consist of contaminated items (e.g., protective clothing) and solidified liquid wastes

(tritiated water absorbed on desiccant and solidified liquid waste from the decontamination area). The

volume of such waste would be similar to that generated by TFTR operations, which was

approximately 7.4 m³ per year for D-D operations and is projected to increase during D-T operations

to 28.3 m³ per year (1,000 ft³ per year) (Speed 1992). Wastes generated during the TPX Project operations would be packaged to comply with applicable DOE and Hanford requirements (e.g.,

Westinghouse 1993) and shipped to the DOE Hanford Reservation in Washington for disposal, as are current PPPL wastes. These wastes would be suitable for disposal with no repackaging required.

DOE policies on waste minimization and pollution prevention would be adhered to by the TPX Project as is currently the case for all other PPPL activities.

A small fraction of the total tritium used for each pulse in the D-T operations would actually

be consumed by fusion reactions; most would be absorbed on solid molecular sieves or recovered by an onsite recycle system currently being developed (TPS), and only very small amounts would be

released to the environment. Amounts that would be absorbed on solid molecular sieves would be collected, packaged in DOE-approved containers, and shipped to a DOE facility (the Savannah River

Plant in South Carolina or the Hanford site in Washington state) for tritium recovery or disposal. If

upgrade to D-T operation occurs, tritium would be shipped to the PPPL site to establish initial inventory requirements, and subsequently to replace that amount shipped offsite plus losses and

inventories that may be trapped in the machine. If the TFTR TPS is utilized, then approximately four

25 kCi containers would be separately shipped to PPPL during the 1-year potential D-T phase of TPX

operation. If the TFTR TPS is not available for TPX use, then approximately one 25 kCi container

of tritium would be required to be shipped to PPPL per week of D-T operation.

Occasionally, small quantities of radioactively contaminated liquids would accumulate. The radioactivity levels of these liquids would be monitored after pumping to outside holding tanks, and if

necessary, such liquids would be solidified and shipped offsite. However, releases to the sanitary

sewer system of liquids contaminated, primarily with tritium, at levels below regulatory limits may

occur. The TPX Project would adopt the current TFTR liquid release limit for all radionuclides.

This limit for tritium is 2×10^6 pCi per liter, which is the Derived Concentration Guide for water in

DOE Order 5400.5 (DOE 1990). Additionally, the project would not exceed the New Jersey

Administrative Code (NJAC) limit of a total annual release of 1 Ci of radioactivity into the sanitary

sewer system (NJAC 1990).

After an expected operating life of approximately 10 years, the TPX facility would be placed in a state of protective custody, the first stage of D&D. This would be similar to the safe shutdown

phase described for TFTR (Section 2.1). Subsequent stages of D&D would take place in accordance with a TPX D&D Plan, which would have been developed prior to initial operation of TPX.

Activities associated with TPX D&D would be evaluated in a future separate NEPA document.

Following safe shutdown, a period of delay would take place, during which time the induced radioactivity in TPX components would be reduced via radioactive decay. Following the delay period, final decontamination of materials, equipment, and buildings would take place. If decontamination to limits specified in a future NEPA document for TPX D&D is not practical, these items would be removed from the site.

2.2.1.5 Safety and Environmental Measures.

The design and operation of the TPX

Project would incorporate safeguards and procedures for safely operating the facility and for handling

radioactive and other potentially hazardous materials. Regulations and procedures are currently in

place at PPPL to protect worker and public health and safety, and the environment. Quality

assurance, emergency response, safety, and monitoring programs are also in place to further protect

potentially affected individuals. These regulations, procedures, and programs would ensure that the

TPX Project facility is operated in the safest manner possible and that the potential negative impacts

resulting from the proposed project are minimized.

The following measures, which are consistent with DOE policies on waste minimization and

pollution prevention, would be implemented as part of the proposed action to prevent or minimize potential negative environmental impacts:

- Tritium seals would be used in tritium handling areas to reduce leakage during cleanup.
- The detention basin is currently monitored for hydrocarbons and other volatile organic compounds, and would accommodate the monitoring of blowdown water and site runoff for other parameters (Stencel and Turrin 1991). The basin also provides for partial settlement of particulates before the runoff and effluent reach Bee Brook (see Figure 3-1). If a spill of hydrocarbons or other volatile organic compounds reaches the basin, sediments would be sampled and characterized to determine the presence of contaminants. Disposal of material would be in accordance with New Jersey State cleanup criteria.
- A new detention cell similar to the existing detention basin would be constructed to maintain the storm water discharge rate to Bee Brook from newly constructed areas at or below the current rates.
- A certified fire control and protection system would be provided.
- The HVAC system has High Efficiency Particulate Air (HEPA) filters to remove particulates (including radioactive particles) that might be entrained in atmospheric effluents. Depending on activities to which they are exposed, the HEPA filters would be characterized to identify quantities of entrained radionuclides, and, if required, would be disposed of as low level radioactive waste at a DOE low level waste site.
- The existing forced draft cooling tower would minimize any potential thermal effluent effects.
- Appropriate onsite areas would be selected near the construction sites for temporary stockpiling of topsoil and other backfill materials during construction. In identifying stockpile areas, consideration would be given to safety and environmental issues (e.g., evacuation routes, floodplains, wetlands).
- Radiation shielding, such as water and lead oxide/boron carbide, would be used to minimize component activation outside of the vacuum vessel.
- Selection of machine construction material would include consideration of low-activation material, such as titanium 6AL-4V selected for the vacuum vessel..

- Design features would be included to accommodate hands-on and remote maintenance.
- Tritium may be recycled during the 1 year of D-T operations to the maximum extent possible, if tritium is used.
- Tokamak operations would be limited, as necessary, to keep radiological releases and doses to design objective limits.
- Features and measures would be incorporated in the design to simplify D&D, for example in-vessel components would be designed for remote removal, and shielding would allow mainly hands-on removal of ex-vessel components and equipment.

2.2.2 Alternatives to the Proposed Action

The following alternatives to constructing and operating the TPX Project at PPPL were considered: the no-action alternative; and siting the TPX Project at a site other than the PPPL site.

2.2.2.1 No Action.

The no-action alternative consists of not constructing or operating the TPX Project. Because conservation of resources and use of existing facilities is most efficient, and because the TPX Project can be built and operated in an environmentally safe manner, the no-action alternative is not preferred. This alternative assumes no further operation of TFTR at PPPL (based upon the DOE Office of Fusion Energy Program Plan).

2.2.2.2 Alternate Site.

This alternative involves siting the TPX Project at a site other than PPPL. The location at the ORR that was previously evaluated for the Burning Plasma Experiment (BPX) Project is used as a reasonable alternate site for the TPX Project for the purposes of this EA because of its recent TPX-scale magnetic fusion machine operating experience, the existence of fusion technology and associated engineering facilities and personnel, an abundance of available electrical power to meet the demands of fusion reactor experimentation, a sufficient amount of unused acreage for the construction of new facilities, and an extensive support and fire protection infrastructure. This site is in the southeast corner of the Oak Ridge Gaseous Diffusion Plant (ORGDP) site about 40 km (25 mi) west of Knoxville, TN. Other than location and new construction required to support

the

TPX Project, this alternative is essentially identical to the proposed action in terms of project requirements, objectives, and scope.

Considerable new construction would be required in order to implement the TPX Project at the ORR. In addition to the construction of the TPX machine (which would be the same as for the proposed action), many new facilities would have to be constructed at the ORR. These new facilities

would include a new test cell, hot cell, waste handling and storage areas, field coil power conversion

building, neutral beam power conversion building, motor generator building, computer and control rooms, cryogenic support building, cooling towers, and office and technical support space. This new

construction at ORR could total as much as 26,000 m² (280,000 ft²) versus 1,250 m² (13,500 ft²) in

new construction necessary at the PPPL site. Although this would add considerable cost to the proposed action, it would provide new capabilities for future nuclear fusion projects at the ORR.

The PPPL is well suited for the TPX Project because of the technical expertise at PPPL and the availability of support facilities and utilities. The net result of siting the TPX Project at a location

other than PPPL, such as ORR, would be major cost increases and schedule delays to the U.S. Fusion

Program. The impact of added TPX construction costs and added experimental program operating costs would make the TPX Project considerably less economical and would jeopardize project funding. The proposed schedule for initial operation of the TPX would also be adversely impacted due to the lead time required to design and construct major new facilities (Test Cell, Power supplies,

etc.) at an alternative site. Increased project costs at alternative sites would make the TPX project

infeasible.

2.3 Environmental Monitoring

The environmental quality and monitoring program currently in effect at PPPL has been designed to ensure that laboratory activities comply with applicable DOE orders and all other applicable Federal, State, and local regulations, standards, and guidelines. In addition to these

specific compliance objectives, the goals of the program are to minimize the radiological and nonradiological impacts of PPPL operations on the local environment and to ensure that radiation doses to workers and the public are as low as reasonably achievable (ALARA). The existing program, including provisions for expansion as necessary, is fully adequate to accommodate the TPX

Project at PPPL. Detailed descriptions of the PPPL environmental monitoring program have been published (Finley, Levine, and Umbaugh 1992; Finley and Stencel 1992).

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3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This section provides a brief description of the potentially affected environment at PPPL for both of the proposed projects. The potentially affected environment consists of the PPPL site and facilities, and the surrounding area that could be impacted by TFTR D&D or TPX construction and operation. A brief description of the ORR alternative TPX site is also included.

3.1 PPPL Proposed Site

The TFTR D&D Project site and the proposed site for the TPX Project at the PPPL is within the existing TFTR Facility (Figure 2-2). PPPL is located in central New Jersey approximately midway between Philadelphia and New York City. It is adjacent to U.S. Route 1, in the Township of

Plainsboro. The following text summarizes the existing environment at PPPL emphasizing the potentially affected environment. Additional information is included in DOE (1992) and Finley and Stencel (1992).

Meteorology and Air Quality Winds are predominately from the west, being more northerly in the winter and more southerly and weaker in the summer. Tabulated joint frequency wind speed data and stability class data are available in (McKenzie-Carter and Anderson 1993). Local air quality is good, and the most recent annual site environmental report (Finley and Stencel 1992) indicates PPPL is in compliance with the requirements of the Clean Air Act.

Visual Environment and Noise PPPL includes a complex of office, research, and industrial buildings that are one to six stories high. The building complex and parking areas have been landscaped with trees, shrubs, and lawns. A border of mature, deciduous, hardwood forest, up to 500 m wide surrounds the PPPL and visually isolates the proposed TPX site from surrounding development. This border also serves to buffer noise from the facility. Ambient noise is moderate and typical of facility complexes of similar size. Noise sources consist primarily of onsite and offsite traffic, HVAC systems, and facility and lawn maintenance activities.

Geology Two soil series are found in the vicinity of PPPL: Fallsington, a poorly drained silty loam characteristic of wet depressions; and Nixon, a better drained loam characteristic of slightly more elevated locales (SCS 1987). Complete geology descriptions are available in ERDA (1975), PPPL (1978), and PPPL (1982).

Seismology The east-central United States, within a radius of 322 km from PPPL, has never experienced a major earthquake in its recorded history; however, many small and moderate earthquakes have been reported in the past 300 years. The design earthquake horizontal accelerations are 0.69 m per sec² (830 year return period) for a "most probable earthquake" and 1.3 m per sec² (2500 year return period) for a "most intense earthquake."

Hydrology Surface drainage is to Bee Brook and its tributaries; this brook is a small perennial stream located about 450 to 600 m east and southeast of the TFTR test cell (Figure 3-1). Its only perennial tributary near the construction site is Drainage Ditch 5. This ditch drains a detention basin which receives cooling tower water effluent, TFTR sump pump water, and storm water from the site. Water from this ditch occasionally affects the temperature of Bee Brook (Finley and Stencel 1992). The TPX site is not within the 500-year flood plain (FEMA 1985). The water table at PPPL has a depth of 0 m at Bee Brook to 8 m near the TFTR facility. The relatively low

NW	261	1934	2486	1672	1340	12725	30822	33696	44825	125370
255,131										
WNW	37	2052	3715	3047	2337	17401	29286	61216	121169	149368
389,628										
W	299	2298	6786	8576	3607	22284	57562	100776	154608	239530
596,326										
WSW	821	1932	2486	3661	3607	22284	67342	108240	344012	285171
839,556										
SW	784	852	1402	1963	2523	18570	67342	279080	784580	733704
1,890,800										
SSW	37	859	1402	1963	2523	18570	56290	50024	119036	342536
593,240										
S	112	860	1407	1963	2523	29712	47665	54080	74360	94210
306,892										
SSE	187	861	1427	1981	2529	18570	64743	69340	101016	119880
380,534										
SE	85	861	1435	2009	2583	23940	62254	76490	92550	25914
288,521										
ESE	299	861	1435	2009	2583	34170	83642	130633	46534	0
302,166										
E	224	861	1435	2009	2583	34170	96395	128782	54224	0
320,683										
ENE	261	861	1435	2009	2583	28475	134374	134438	872015	1886392
3,062,843										
NE	336	861	1435	2009	2583	34170	130985	407730	1462478	3004870
5,047,457										
NNE	112	861	1435	1908	2453	19025	105180	298590	535723	439534
1,404,821										
<hr/>										
TOTAL	4,591	18,469	32,431	40,329	1,433	62,061	1,146,773	2,074,202	5,028,705	7,626,473
16,375,467										
<hr/>										

Ecology The proposed construction site is currently bare ground and gravel previously disturbed by the other construction and contains only a few scattered forbs and grasses; wildlife consists of roosting and possibly nesting rock doves. Other common species typically inhabiting barren sites (e.g., mice, sparrows, snakes, toads) may also seasonally use the site. The vegetation of the wooded area surrounding PPPL is characterized by relatively mature red oak, beech, and tulip-trees as well as white oak and hickories; wildlife in this area includes white-tailed deer, gray squirrel, eastern cotton tail, and ring-necked pheasant. Large mammals are excluded from the construction site by a fence. Wetland delineation studies at PPPL were recently completed and results are shown in Figure 2-2 (Taylor et al. 1993). Bee Brook represents a slightly enriched aquatic ecosystem with a moderately healthy benthic macroinvertebrate community. Additional information on the ecology of the area in and around the proposed site (including the wetlands) is in EnviroSphere (1987) and Edwards and Kelcey (1988).

Figure 3-2. PPPL area land use plan (Source: Princeton Forrestal Center, Princeton, NJ).

Threatened and Endangered Species No threatened or endangered species have been identified at the site (Envirosphere 1987; Chezik 1987). Potential habitat for some species does occur in the area surrounding the site, beyond the area of direct influence. Section 7.0 contains consultation letters regarding endangered and threatened species.

Historical and Archaeological Resources There are no identified historical or archaeological resources at the proposed site. An archaeological survey of the site was conducted prior to TFTR construction, and no items of archaeological value were identified (Grossman 1977). Section 7.0 contains a copy of a consultation letter regarding historical and archaeological resources.

Radiological Conditions The annual effective dose equivalent (EDE) at the TFTR facility boundary (and at the PPPL site boundary) from all PPPL operations has been less than 1 mrem (Finley and Stencel 1992); this dose is less than 1% of the DOE EDE limit (100 mrem per year) for all public exposure modes (DOE 1990). The natural background radiation dose in the vicinity of PPPL amounts to approximately 600 mrem per year; this dose rate includes a contribution of approximately 500 mrem per year from exposure to radon, for which the average indoor concentration in Plainsboro township is approximately 3.1 pCi per liter (Finley and Stencel 1992; Greco 1990).

Surface water and groundwater analyses for radioactive contaminants have detected tritium levels of less than 100 pCi per liter. These levels are consistent with background tritium levels. Less than one curie of radioactive airborne effluents (Ar-41 and tritium) was released from TFTR to the atmosphere in 1991 (Finley and Stencel 1992).

Monitoring for potential sources of radiological exposure and contamination consists of real-time prompt gamma/neutron monitoring (which includes an integrating capability) around TFTR, and collection of soil, vegetation, surface water, and groundwater samples from onsite and offsite locations. Results of the monitoring program are published annually (e.g., Finley and Stencel 1992). None of the sample analyses conducted thus far have shown the presence of any radionuclide at levels higher than background levels (Finley and Stencel 1992).

3.2 ORR Alternative Site

The ORR alternative site for the TPX Project is located in the southeast corner of the ORGDP site about 40 km (25 mi) west of Knoxville, TN (Figure 3-3). Some existing buildings at the ORGDP site would be used along with some new facilities that would be constructed to the south and east of the K-1220 building (Figure 3-4). The site is approximately 400 m (1,300 ft) from State Highway 58. The following text summarizes the affected environment at ORR. Additional information on the existing environment at ORR is in Jacobs and Wilson (1990).

Meteorology and Air Quality Winds at the ORR site have a pronounced bimodal wind-direction pattern which consists of prevailing up-valley (from the southwest) and down-valley (from the northeast) flow. The opposing forces of regional and local winds counteract one another to yield a high occurrence of the lowest wind-velocity classes (54%) and of calm periods (23%). ORGDP site operation effluents did not exceed any air quality standards in 1989 (Jacobs and Wilson 1990).

Visual Environment and Noise The ORR alternative site visually resembles a large industrial manufacturing-type facility. Poplar Creek runs through the site, and the Clinch River runs south and west of the site. Large wooded or natural areas are scattered primarily outside the ORGDP site or along the waterways. The entire region is known for its scenic quality. Ambient noise at the ORR site is moderate and typical of facility complexes of similar size. Noise sources consist primarily of onsite and offsite traffic, HVAC systems, and facility and lawn maintenance activities.

Geology The typical soils around the ORGDP site are red-yellow podsolic, reddish-brown lathyratic, and lithosols. They usually are strongly leached, acidic, and low in organic content. The depth of alluvium beneath the ORR site area ranges from near zero to 18.3 m. A complete description of the geology of the ORR area is available (DOE 1979; Jacobs and Wilson 1990).

Seismology The ORR is crossed by two major thrust faults: the Copper Creek fault in the southeastern part of the reservation, and the Whiteoak Mountain fault in the northwestern part. No evidence has been found of activity associated with these faults during the past 230 million years. The maximum earthquake for the region was predicted as having a maximum acceleration of 1.47 m per sec² (return period of 520 years) (DOE 1984; Coats and Murray 1984).

[Figure 3-3. General site plan for the TPX ORR alternative location showing TPX facilities.](#)

[Figure 3-4. Location of major surface water bodies in the vicinity of the ORR site.](#)

Hydrology Surface drainage from the ORR site is to Poplar Creek and its tributaries. The lower portion of Poplar Creek flows through the ORGDP to its confluence with the Clinch River approximately 1.6 km downstream. Additional information regarding area surface waters (DOE 1979; Loar 1984) is available. The water table around the ORR site has a depth range of 3 to 10 m.

Groundwater depth varies with the seasons and soil characteristics. Groundwater movement is to the west towards Poplar Creek. Additional information is available (Geraghty & Miller, Inc. 1986; Moore 1988; Jacobs and Wilson 1990).

Ecology The ORR site consists of lawn, pavement, and bare ground previously disturbed during ORGDP facility development. Appalachian oak forest is the potential natural vegetation of much of the region. Climax types found in coves interspersed along the dissected ridge system consist of northern hardwoods. Currently, most of the region is covered by a second-growth forest

composed of several plant communities. More specific descriptions of these plant communities (DOE

1979) are available. Many of the wildlife species found near the site are typical of those in east

Tennessee. The aquatic communities in lower Poplar Creek are described by Loar (1981) in a 1977-78 survey of the aquatic habitats in the vicinity of the ORGDP. Generally the aquatic ecology

near the ORR site is typical of slow moving, open streams in the area. Additional information on ORR site aquatic ecology is available (DOE 1979; Loar 1984).

Threatened and Endangered Species No threatened or endangered species have been identified at the ORR site (DOE 1979; Parr 1987; Kroodsma 1987).

Historical and Archaeological Resources Four historical sites within 16 km are listed on the National Register of Historic Places, and 45 archaeological sites, mostly along the Clinch River at

the ORGDP, have been identified (DOE 1979). No such resources are known to exist at the alternative site.

Socioeconomic Environment The area around the ORR site has a much lower population density than central New Jersey and a much slower but steady rate of growth. The total population within an 80-km radius of the ORR was approximately 845,137 in 1980. The estimated population within an 80-km radius of the ORGDP was recently estimated to be 907,757 (Jacobs and Wilson 1990). The ORR has been a major source or contributing source of employment in the region surrounding the alternative site. The three major ORR installations employ an average of 15,000 to 16,000 people (Stair 1987). Manufacturing, much derived from government contracts, accounts for 33% of all local employment (DOE 1986).

Interstate 40 is located 10 km south of the proposed ORR site and carries an average daily traffic volume of 16,500 vehicles. State Highway 58 runs along the edge of the site and provides the major entry. A major railroad and one major airport are located 13 to 37 km away.

Potable and nonpotable water comes from the Clinch River (DOE 1979). The Clinch River has an ample supply of water for all current users. Electricity, sufficient for present and future demands, is supplied by the Tennessee Valley Authority.

Radiological Conditions The ORR facilities and the radioactive waste disposal areas contribute radioactive emissions to the atmosphere, water, and land; radioactivity in these media has been monitored for several years (Jacobs and Wilson 1990). Approximately 123,000 Ci of radionuclides were released to the atmosphere from ORR facilities in 1989; approximately 23% of this total was tritium. The calculated annual dose resulting from airborne releases in 1989 to the maximally exposed offsite individual was 1 mrem (EDE); the summed collective committed effective dose to the population within an 80-km radius of each ORR facility during 1989 was 35 person-rem (Jacobs and Wilson 1990). The individual dose from all sources of background radiation in the ORR area is approximately 300 mrem per year, which corresponds to a population dose of 280,000 person-rem for the population within 80 km of ORR (Jacobs and Wilson 1990).

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4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED

ACTIONS AND ALTERNATIVES

4.1 TFTR D&D Project

The impacts of the TFTR D&D Project are presented in this section. The discussion in Section 4.1.1 generally assumes that normal D&D operations occur, established D&D procedures are adhered to, monitoring and mitigative measures would function as designed, and all Federal, State, and local regulations are followed. Section 4.1.2 presents details on environmental impacts associated with abnormal D&D operations and accidents. Sections 4.1.3, 4.1.4, and 4.1.5 summarize unavoidable adverse impacts, irreversible and irretrievable commitments of resources, and cumulative and long-term effects of the proposed action, respectively. The impacts of the alternatives are compared against the proposed actions in each of the following subject areas.

4.1.1 Impacts of Normal D&D Operations

The following subsections address the maximum environmental impacts expected from normal D&D operations at the TFTR facility. The impacts of the two alternatives to the proposed action (no action and delayed D&D) are discussed in the appropriate subsections.

4.1.1.1 Nonradiological Impacts of Normal Operation. Nonradiological impacts evaluated for the proposed TFTR D&D Project include: air quality, noise, water quality and quantity, aquatic and terrestrial ecology (including threatened and endangered species), visual environment, land use, historical and archaeological resources, and socioeconomic environment. There would be minimal adverse impacts to the visual environment due to the proposed project (or alternatives) because new construction of the RWSB would take place within the fenced area of the PPPL D-site complex, the construction of the second storm water detention cell would take place adjacent to the existing detention basin, and virtually all D&D activities would take place inside the TFTR Test Cell Complex. There are no identified historical or archaeological resources, or threatened or endangered species at the proposed site. The terrestrial ecology (resident animals) may be temporarily disturbed by the increased noise associated with the new construction. Some impacts due to the TFTR D&D are possible and are described in the following paragraphs. Impacts generally apply to all alternatives, except construction impacts, which do not apply to the no-action alternative. Nonradiological impacts for the delayed D&D alternative would be essentially the same as for the proposed action, but delayed.

Air Quality. Airborne emissions during construction of the RWSB and storm water detention cell would include fugitive dust and vehicle emissions. Dust would be controlled as needed by spraying water or other mitigative procedures. Vehicle emissions would be expected to be similar to other small construction projects. Nonradioactive atmospheric releases during D&D operations from the facility should not increase beyond those currently experienced by on-going TFTR operations, which are now in compliance with the Clean Air Act as well as applicable provisions in New Jersey regulations. The no-action alternative would have the least emissions, because only those operations needed to place and maintain the facility in protective custody would be performed, and no new construction would occur.

Noise. Noise levels at the site would temporarily increase during the construction of the RWSB and storm water detention cell, and would be experienced by PPPL employees during the construction period. However, the general public should not be impacted by noise because the nearest offsite occupied area is 350 m (1,150 ft) from the TFTR stack and there is a buffer zone of forested area surrounding the site. For D&D operations, noise levels would not exceed the current levels associated with TFTR operations. The appropriate provisions of the New Jersey Administrative Code (Title 7, Chapter 29, Noise Control) would be adhered to. For the no-action alternative, there would be no construction noise.

Water Quality and Quantity. During construction there would likely be a temporary and slight increase in the sediment load transported to Bee Brook via Drainage Ditch 5 after capture in the existing detention basin. Erosion and sedimentation would be controlled by mitigative procedures described in Section 2.2.1.5. Additionally, minor chemical spills such as fuel oil or other chemicals associated with construction could occur. PPPL has a Spill Prevention Control and Countermeasures Plan in place for cleanup and control of inadvertent spills.

Nonradioactive liquid effluents would be the same as current liquid effluents, and would consist of site surface water runoff and sump pump water that would be released to Bee Brook. Blowdown water, sump pump water, and runoff at the PPPL site are currently discharged to Bee Brook through Drainage Ditch 5 and provide up to 90% of the flow of Bee Brook. There are currently discussions between the State of New Jersey and PPPL concerning the temperatures of the discharges and possible means of control (Finley and Stencil 1992). It is anticipated that engineering measures would be undertaken prior to D&D operations to ensure that the temperature of the water entering Bee Brook from Drainage Ditch 5 meets appropriate NJDEPE requirements. For the no-

action alternative, the current discharge to Drainage Ditch 5 would remain the same as the current

discharge, due to the operation of the sump pumps operated to prevent flooding of the TFTR basement. Permit modifications for the new storm water detention cell would be requested under the National Pollutant Discharge Elimination System program.

Aquatic Ecology. Construction may result in increased sedimentation into Bee Brook. Impacts to the aquatic ecology from siltation and possible chemical spills are described in Section

4.2.1. Per U.S. Fish and Wildlife Service recommendations (see Section 7), and consistent with the

PPPL NJPDES surface water permit, precautions (e.g., covering, seeding, mulching and/or diking of disturbed areas, stockpiled soil and other areas subject to erosion) would be taken to protect and

maintain the water quality of Bee Brook during TFTR D&D operations and construction of the RWSB and storm water detention cell. Based on previous construction experience at PPPL and the effectiveness of the storm water detention basin, negative impacts from sediment loadings are expected

to be minor, temporary, and reversible.

The no-action alternative would not involve construction impacts to aquatic ecology. The sump pump discharge to Drainage Ditch 5 would continue, and there would be no change in the flow quantity to Bee Brook.

Land Use. The approximately 950 m³ (33,550 ft³) of radioactive wastes generated by TFTR D&D operations would have to be transported for disposal offsite. This volume would not adversely

impact the capacity of offsite disposal facilities (e.g., the disposal facility at the DOE Hanford site,

which has the capacity to accept many million cubic meters of low level radioactive waste).(a,b) Approximately 560 m² (6,000 ft²) of space within D-site would be used by the RWSB on land allowed for development by the contract between PPPL and DOE. Approximately 1,300 m² (14,000 ft²) of

a Potential impacts associated with disposal of large volumes of radioactive waste at Hanford have

been evaluated (e.g. DOE 1975).

b The Hanford Waste Facility EIS (DOE 1975) was recently reviewed and approved by DOE Richland Operations Office for acceptability of continued waste management operations (J. Commander 1/25/94

Correspondence with R. Funk, DOE Hanford Site).

space adjacent to the existing detention basin would be used to construct a second storm water detention cell. The no-action alternative would not impact land use.

Socioeconomic Environment. The required TFTR D&D workers for construction of the RWSB and D&D operations (an average of 10 workers over the RWSB construction period and 100 workers over the duration of D&D) would be available from the local labor pool, so the project would not place any increased demand on services or schools.

Following the completion of the proposed action, the no-action, or the delayed D&D alternative, most jobs associated with operation of TFTR (approximately 220) would be eliminated. However, this job loss may not occur because of the possible transition of jobs to the proposed TPX Project at PPPL.

4.1.1.2 Radiological Impacts of Normal Operations-Public. Annual radiation doses from normal TFTR D&D operations could result from liquid releases, airborne releases, and direct and scattered radiation. Airborne releases would consist primarily of residual tritium and activated dust from cutting activities, but these releases would be greatly minimized by the use of control tents around the area of the cutting. Direct and scattered radiation from the RWSB, from inside the TFTR Test Cell due to previous neutron activation of components, and from waste shipments also represents a possible source of public exposure. The TFTR D-T Project has adopted a design objective dose of 10 mrem per year as a maximum allowable individual dose from all TFTR sources to any member of the public (PPPL, 1992a). This design objective would also be adopted for the TFTR D&D operations. The term "dose" as used in this EA refers to the effective dose equivalent (EDE) unless otherwise stated. Soils that would be disturbed during construction activities are not expected at the present time to be contaminated with radioactive material; if any such soils are found to contain radioactive material, they would be managed in accordance with NJDEPE and relevant Federal requirements.

Liquid Releases Liquid releases during TFTR D&D would be limited to 1 Ci per year, with a resultant dose of 0.02 mrem per year and an increased probability of health effects of 1.0 10⁻⁸ (DOE 1992). Low tritium concentration in any released liquids, combined with subsequent dilution downstream of PPPL, would result in a negligible population dose from liquid releases.

Airborne Releases Airborne releases during TFTR D&D would consist of small amounts of activated metallic dust, and small amounts of fugitive tritium (Section 2.1.1). Using conservative assumptions regarding atmospheric dispersion (NOAA 1989) and public receptor characteristics, a maximum potential individual dose from radioactivity released during TFTR D&D cutting activities

was estimated (Commander 1994). The calculated dose is 2.2 mrem per year at the PPPL site boundary resulting primarily from the assumed release of tritium. Based on this dose the increased probability of health effects is 1.1×10^{-6} . The airborne tritium release would result in a population dose of approximately 10 person-rem per year with less than 1 (.005) fatal cancer expected in the exposed population. This is less than 0.001% of the background dose rate received by the population surrounding PPPL. The delayed D&D alternative would result in a smaller dose at the PPPL site boundary due to the additional radioactive decay of the TFTR radiological inventory. The no-action alternative would not result in any airborne releases of radionuclides.

Direct and Scattered Radiation (Public). The test cell shielding structure would limit direct radiation from activated components inside of the TFTR Test Cell during normal TFTR D&D operations to less than 0.1 mrem with an increased probability of health effects of less than 5.0×10^{-8} per year at the site boundary. This estimate is based on the estimated activation levels given in the TFTR D&D Plan (PPPL 1993a), and conservatively estimated transmission through the Test Cell walls. Because the individual direct and scattered dose rate would decrease rapidly with increasing distance (roughly as the square of the distance), the potential total population dose within 80 km (50 mi) from TFTR D&D activities would also be very small. Appropriate safety analyses would be conducted to ensure that the storage (within the TFTR Facility or in the new RWSB) of activated components removed from the test cell would not pose a hazard to workers or the public. The no-action and delayed D&D alternatives would result in even less potential radiation exposure at the site boundary.

Members of the public along the route of the waste shipments could also receive small doses from the passing trucks. The members of the public considered as potentially receiving a dose from these shipments are persons living near the transport route, persons sharing the transport route, and persons at stops. The total estimated annual population dose to members of the public from 55 shipments of waste from PPPL to Hanford each year is 31 person-rem. This estimate was calculated with the RADTRAN computer code (Neuhauser and Kanipe 1992), and assumes that the dose rate at 2 m from the exterior of the shipment vehicle is the maximum value allowed by the Department of Transportation in 49 CFR 173 for exclusive use shipments of radioactive materials (10 mrem/hr). There would be an estimated increase of less than one fatal cancer (0.02) in the exposed population from this population dose.

4.1.1.3 Occupational Impacts of Normal Operations.

Occupational Radiological Doses. Direct and scattered radiation present during TFTR D&D operations within the Test Cell Complex would constitute the primary source of occupational exposures. DOE Order 5480.11 contains radiation protection standards and program requirements for DOE and DOE contractor operations. Doses to TFTR D&D Project workers from exposure to airborne releases, direct and scattered radiation, and radioactive waste are expected, but would be controlled and maintained below the annual DOE standard of 5 rem EDE, as well as the PPPL administrative limit of 1 rem per year. This would be accomplished and enforced with the use of administrative controls, monitoring, and precautionary measures (e.g., use of dosimeters within areas and on personnel; and evaluation, assessment, and preplanning of activities prior to entry to radiologically controlled areas and following radiological assessment by PPPL Health Physics). Airborne tritium levels in the test cell would be monitored and precautionary measures would be taken; therefore, routine occupational exposures to tritium would be minimal.

For the purposes of estimating potential impacts associated with shipping radioactive waste generated during TFTR D&D, the DOE waste disposal site at Richland, WA can be assumed to be the designated disposal site. The external radiation exposure rate in the vicinity of the waste containers is not known, but PPPL would not exceed the DOT regulatory limit that restricts the dose rate in the cab of a transport truck to a maximum of 2 mrem/hr. Assuming a total road time of 57 hours and the maximum allowed dose rate, the driver of a waste shipment from PPPL to Hanford would receive a dose of 133 mrem per shipment. This estimated dose includes miscellaneous activities other than driving, such as inspecting the load. The actual dose to a driver would be contractually monitored, reported, and limited to no more than the PPPL administrative limit of 1 rem per year, which would correspond to an increased probability of health effects of 4×10^{-4} per year.

The no-action alternative would have the least occupational radiological doses since the workers would receive only those doses associated with safe shutdown and protective custody. D&D activities would be excluded in this alternative. The delayed D&D alternative would also result in lower radiological doses to workers as compared to the proposed D&D project since the 2 to 3 year delay would allow some radioactive decay of contaminated components within the TFTR facility prior to commencement of D&D activities.

Nonradiological Occupational Impacts. Conduct of construction or TFTR D&D operations would involve routine industrial hazards (e.g., the use of construction equipment, handling equipment, and cutting tools). However, these industrial hazards could be easily managed via standard safety,

engineering, and administrative controls. Operational and shipping accidents related to D&D are discussed in Section 4.1.2.

4.1.2 Impacts of Abnormal D&D Operations and Accidents

The TFTR D&D Project design basis accidents include four general categories of events identified which could result in the accidental release of radioactive materials. The categories are:

natural phenomena, accidents with external origins, shipping accidents, and operational occurrences.

They are discussed in Sections 4.1.2.1 through 4.1.2.4. Potential occupational doses are discussed in

Section 4.1.2.5; and accidents involving nonradiological occupational impacts are discussed in Section

4.1.2.6. Discussion here is focused on scenarios classified as credible (i.e., having probability of

occurrence greater than 10^{-6} per year, (or one or more occurrence in one million years) (Elder et al.

1986). Events that are most likely to occur and those having the most potentially serious

consequences are emphasized. Reilly (1993) gives a complete discussion of the potential

consequences of various accident scenarios for TFTR-D&D, and all summaries in Sections 4.1.2.1

through 4.1.2.5 are extracted from this document. The potential consequences are conservative, since

they are based on a 1-year radioactivity decay period, whereas the current plan is to allow a 2-year

decay period prior to the start of D&D activities. All calculated accident radiation doses are based on

dispersion values obtained from the recent National Oceanic and Atmospheric Administration (NOAA)

dispersion tests (Start et al. 1989). McKenzie-Carter et al. (1991) gives a description of the

methodology used to calculate individual and population doses.

The proposed TFTR D&D Project, the no-action alternative, and the delayed D&D alternative would all involve a safe shutdown of the TFTR facility. The risks for the no-action alternative would

essentially be those associated with the safe shutdown of the facility. There would be some risks

associated with placing the facility in protective custody (i.e., mothballing), however, these would be

bounded by the risks associated with safe shutdown, which involve potential releases of tritium

inventories. If the facility were mothballed other radionuclides would be immobilized in components

and would not be subject to potential release. The principal radiological risks during safe shutdown

consist of a subset of the tritium accident risks existing during TFTR D-T operations. Therefore,

although Reilly (1993) examined risks during safe shutdown, only those involving a tritium accident

are discussed here (see Section 4.1.2.4).

The risks associated with the delayed D&D alternative would be comparable to or less than those for the proposed TFTR D&D Project, since the additional time before D&D operations began would result in lower inventories and releases of some activation products.

4.1.2.1 Natural Phenomena. Severe natural phenomena have the potential to cause accidents since they could disable protective systems surrounding radionuclide sources. Earthquakes and severe winds (tornados and hurricanes) are the principal concern at PPPL since they could disable electrical power. During safe shutdown natural phenomena are not significant (DOE 1992). Risks during D&D activities exist because some seismically designed structures would be degraded, however radionuclide inventories would be much less than for D-T operations. In addition, D&D operations are fail-safe with respect to loss of electric power: they can merely be discontinued during severe weather, with no consequence to workers, the public, or the environment.

Generally, TFTR radiological inventories during D&D would be much smaller than during D-T operations (DOE 1992, Appendix C). Estimated frequencies, radiological releases to the environment, and the resultant doses to workers and the public due to accident scenarios assessed (Reilly 1993) are listed in Table 4-1.

4.1.2.2 Accidents with External Origins. Explosions or releases from nearby industrial facilities, transportation accidents involving radioactive or hazardous materials, dam failures, airplane crashes, etc. are not considered here because the likelihood of such events occurring and causing damage to the TFTR has been shown to be negligible (Holland et al. 1991).

4.1.2.3 Shipping Accidents. Risks associated with D&D of TFTR include those due to accidents occurring during transportation and disposal of radioactive wastes. This risk assessment will address only transportation risks, since risks at waste disposal sites are addressed in disposal site documents. Approximately 110 truck shipments of Type A waste containers to Hanford over a 2-year period are assumed (the most distant possible disposal site, a 2,700 mile one-way trip). The probability of a container failure during transportation as a result of a transportation accident is about 5×10^{-4} per year, or 1×10^{-3} for the 2 year period (for all of the containers shipped) (see Table 4-1). Container failure would not necessarily lead to a release since most of the radioactivity would be activation products contained in solid metal parts encapsulated in the containers and there is not likely to be an energetic driving force for leakage from the containers.

Table 4-1. TFTR D&D accident frequencies and consequences.

Probability of Scenario health effects	Frequency (yr ⁻¹)	Release to environment(a)	Worker		Public
			Individual dose (mrem)	Probability of health effects	Individual dose (mrem)
Safe Shutdown (SS) (e)					
Beyond design basis event, 2.0X10 ⁻⁴ 25 kCi tritiated water released from U-beds to room, no cleanup, stack booster fan fails, ground- level release	<1X10 ⁻⁶	25kCi	0.08	4.0X10 ⁻⁸	390
D&D Operations (f)					
Temporary loss of contamina- 2.4X10 ⁻¹⁰ tion control envelope during cutting	1.5	37uCi	6.2X10 ⁻²	3.0X10 ⁻⁸	4.7X10 ⁻⁴
Vacuum bag rupture during 5.0X10 ⁻¹⁰ cutting	1.5X10 ⁻²	77uCi	0 (b)	0 (b)	1.0X10 ⁻³
Inadvertent worker exposure 0 (c) to tent atmosphere	1X10 ⁻²	0 (c)	0.39	2.0X10 ⁻⁷	0 (c)
Fire of explosion during 3.2X10 ⁻¹⁰ flame cutting	5X10 ⁻²	50uCi	8.4X10 ⁻²	4.2X10 ⁻⁸	6.4X10 ⁻⁴
Fires involving contaminated 8.0X10 ⁻¹² clothing or combustible	6X10 ⁻³	1.2uCi	2.0X10 ⁻³	1.0X10 ⁻⁹	1.6X10 ⁻⁵

waste (not started by flame cutting)

Leak from closed-circuit system during water-spray decontamination	1×10^{-2}	14uCi	2.3×10^{-2}	1.2×10^{-8}	1.7×10^{-4}
Load dropped from crane	5×10^{-2}	15uCi	2.5×10^{-2}	1.2×10^{-8}	2.0×10^{-4}
Seismic event within design basis	1×10^{-1}	50uCi	8.4×10^{-2}	4.2×10^{-8}	6.4×10^{-4}
Transportation accident (d)	5×10^{-4}	4uCi	1.4×10^{-4}	5.6×10^{-11}	1.4×10^{-4}

Nonradiological risks	Number of Injuries	Number of Fatalities
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Construction risks (RWSB)	0.2	4.5×10^{-5}
Nonradiological risks in facility	0.48 (SS) 4.4 (D&D)	1.3×10^{-3} (SS) 1.2×10^{-2} (D&D)
Nonradiological risks during transportation of radioactive wastes	0.013 (SS) 0.44 (D&D)	7.8×10^{-4} (SS) 2.9×10^{-2} (D&D)

a Unless otherwise noted, release consist of metal activation products. Source: Reilly (1993)

b No radioactive material is released to any areas occupied by workers in this scenario.

c No radioactive material is released to any areas outside PPPL in this scenario.

d The dose calculation for this scenario used a generic reference value for estimating the dose; no distinction

was made between workers and members of the public, and the worker dose was assumed to be the same as the

public dose

e The collective population dose for the safe shutdown scenario is 1,710 person-rem, and the calcauted number

of health effects from this dose is 0.86.

f Collective population doses and health effects would be negligible for all D&D operations scenarios.

4.1.2.4 Operational Occurrences. Operational occurrences reviewed for TFTR D&D operations include loss of tent confinement during D&D cutting operations, explosions or fires, lifting/rigging accidents, and tritium accidents. Table 4-1 summarizes the risks associated with these operational occurrences. Transportation and radioactive waste warehousing type accidents within the D-site boundary would not be expected to exceed those occurring during TFTR D-T Operations (DOE 1992, Section 4.3.4).

Loss of tent confinement during cutting operations would not be consequential to the public, but would allow airborne radioactive aerosols and dust to escape into the test cell or hot cell. The maximum concentration workers could be exposed to for a long duration would be that which would be too low to set off the local continuous air monitoring systems alarms. If undetected, exposures could occur to workers in the cell. In the event of a significant leak of radioactive material to the test cell or hot cell, workers could inhale some radioactive aerosols and dust while evacuating the facility.

Explosions or fires could occur during oxyacetylene flame cutting operations. The only explosive or flammable materials would be the acetylene gas supply bottle for the cutting torch. Actually, cutting may employ some other method not employing flames. Only one acetylene gas supply bottle would be used at one time for a given torch cutting machine in the test cell or hot cell. At this stage in the planning most cutting operations would be done in the hot cell using arc saws and plasma arc cutting methods, which do not use gas and therefore require no flammable material for operation. Arc saw cutting operations in the hot cell may be done remotely, with personnel restricted to the gallery side of the hot cell, so that no worker doses would occur in the event of an accidental release during cutting. Plasma arc cutting operations would normally occur in the Test Cell and would be performed remotely.

Fires could also be caused by motor failures or short circuits in electrical equipment. As a precaution, there would be no permanent, and only minimal transient, combustible material in the test cell and hot cell. Portable HEPA filters could conceivably be damaged by fire and caused to release their radioactive inventory. However, a fire severe enough to damage the facility HEPA filters could not occur, since the amount of cumulative material in the cell will be small, the test cell and hot cell fire suppression systems will be operational during D&D operations, and facility HEPA filters are protected by roughing pre-filters. In addition, Test Cell and Hot Cell HVAC Systems would be shutdown on smoke detection or sprinkler flow indication. A conflagration is not considered

credible

since there would be insufficient combustible material available to sustain a fire. The test cell and hot

cell are heated by imported steam, so there would be no possibility of fire caused by the heating system.

Equipment movements in the test cell and hot cell would be done by electric overhead cranes or electric or propane powered forklifts. Lifting/rigging accidents would not be a significant radiological risk to the public because they could not breach building confinements, therefore releases

of radioactive liquids or particulates would not be considered credible. Radiological release from a

lifting/rigging accident could not exceed the amount of radioactive dust released from dropping and

breaching one shipping container (see Table 4-1). Approximately 2,000 crane movements of radioactive material are expected, which would impose industrial accident risks, (see Table 4-1).

Some small possibility would exist for tritium release accidents during safe shutdown and D&D. A series of tritium release accidents were examined for safe shutdown, and the bounding accident is listed in Table 4-1. During D&D, a tritium release during removal of the graphite tiles

from the inner surfaces of the torus was examined. The trapped tritium could be released from the

tiles during this operation. The amounts of tritium involved in the tile removal accidents would be

much smaller than amounts involved in hypothetical accidents during D-T operations (35 Ci versus 25 kCi) which have been evaluated previously (DOE 1992).

4.1.2.5 Occupational Doses. There would be a potential for direct radiation exposures to workers. Radiation levels at the inside surface of the test cell after 1 year of cool down are estimated

to be less than 1 mrem per hour. Radiation levels at the outer surface of the tokamak support columns would be about 2 mrem per hour. The maximum level to which a worker could be exposed is at the outboard side of the TF coil case and would be about 70 mrem per hour. Levels in the vacuum vessel interior would be as high as 800 mrem per hour (Ku 1991), although personnel would be administratively excluded from radiation fields this high. D&D operations outside the TF coil boundary could be hands-on, while D&D operations inside that boundary would be done with semi-remote or fully remote equipment. Some radiation levels would be elevated; a few seconds or even minutes of exposure to the highest of these radiation fields would still be within exposure limits. For

example, five minutes of inadvertent exposure to the radiation field at the outside of the TF coil would

result in a dose of 6 mrem, which is much less than the PPPL quarterly allowable dose for occupational exposures (600 mrem). External radiation doses would be measured by personnel dosimeters which would be read frequently during operations. Therefore, if both radiation zone control and local (at work location) radiation alarms failed and a worker inadvertently worked 8

hours

next to a highly-radioactive component, assuming a radiation level 70 mrem per hour like that of the

TF coil, the dose could be as great as 560 mrem. In any event, mitigative measures (e.g., evacuation,

use of protective equipment, implementation of emergency response procedures) would keep the EDE to any individual worker within the PPPL emergency exposure limits specified in Section 10 of PPPL

Environment Safety and Health Manual, ESHD-5008 (PPPL 1992a). All radiation exposures to workers would be held to the principles of ALARA.

4.1.2.6 Nonradiological Occupational Impacts. Nonradiological risks during construction of the RWSB, safe shutdown, and D&D, were estimated using available databases and are listed in Table 4-1. These estimates assume a 7 month construction period for the RWSB with 10 workers, 30 worker-years during safe shutdown, and 260 worker-years during D&D.

These accident rates are representative of hazards associated with many industrial facilities

and would not be unique to the TFTR facility. The present risks of worker accidents at TFTR would

not be increased by the TFTR D&D Project, including construction of the RWSB, or by any of the alternatives.

4.1.3 Unavoidable Adverse Impacts

Proceeding with the TFTR-D&D Project would result in some unavoidable adverse impacts.

There would be a statistical probability of injuries and fatalities occurring during construction of the

RWSB, during D&D operations in the TFTR Test Cell Complex, and during transportation of

radioactive wastes from PPPL to the waste disposal site. A maximum of 7 injuries and 0.018 fatalities

is estimated to occur during D&D operations, including construction and transportation (Reilly 1993).

The potential would exist for radioactive airborne emissions from D&D operations, however the projected impacts to occupational workers, the public, and the environment, though unavoidable,

would not result in any discernible cancer mortalities or genetic effects (Reilly 1993).

All radioactive waste material resulting from TFTR D&D, would be shipped to a designated DOE disposal site presently assumed to be at Westinghouse Hanford at Richland, WA. The unavoidable impact would consist of the shipment and disposal of 2,270 tonnes (2,500 tons) of Class

A Low Level Radioactive Waste. Shipments of radioactive waste would meet the transportation radiation criteria of 49 CFR 170-189.

4.1.4 Irreversible and Irretrievable Commitments of Resources

The proposed TFTR D&D Project (including safe shutdown) would require support utilities similar to those currently supplied to the TFTR Project. Approximately 600,000 worker-hours of labor would be expended during the D&D operations including construction of the RWSB and storm water detention cell. Land or space elsewhere would be committed for receiving radioactive and nonradioactive waste generated during D&D activities.

4.1.5 Cumulative and Long-Term Impacts

Since TFTR operations would be discontinued prior to initiation of the proposed TFTR D&D Project, and because no long-term impacts are anticipated to result from TFTR operations (DOE 1992), operational cumulative effects are expected to be minimal between TFTR operations and TFTR D&D. The TFTR D&D Project would represent a continuation of, rather than a change in, any impacts (negative and positive) associated with TFTR operations.

No adverse cumulative impacts with other PPPL projects are anticipated. Direct radiation from other PPPL devices PBX-M are expected to contribute less than 1 mrem/yr to the D-site environs

(Finley and Stencel 1992), so cumulative impacts from direct radiation are expected to be minimal.

Increased traffic during the RWSB construction and TFTR D&D Project operations would be a temporary minor impact, and would be cumulative with other traffic on and near PPPL. This traffic

impact may be partially offset by the possible loss of some PPPL jobs due to termination of TFTR D-T operations.

Commitments of approximately 560 m² (6,000 ft²) of land for the construction of the RWSB, and approximately 1,300 m² (14,000 ft²) of land for construction of a second storm water detention cell, would represent the only long-term impact of the TFTR D&D Project, that being a long-term commitment of land use.

The calculated maximum individual radiological dose to any individual member of the public resulting from each year of TFTR D&D operations from all pathways is approximately 2.3 mrem (Section 4.1.1.2). Therefore, the maximum cumulative dose to any member of the public resulting from 2 years of D&D operations would be approximately 4.6 mrem. This dose would result in an increased probability of health effects of 2.3×10^{-6} (2.3 chances in 1,000,000). The calculated population dose resulting from each year of TFTR D&D operations is 41 person-rem (10 person-rem from airborne releases and 31 person-rem from waste shipments) (Section 4.1.1.2), therefore the maximum cumulative population dose would be 82 person-rem. No estimated health impacts would occur in the exposed population based on this calculated population dose (the calculated number of

fatal cancers is 0.04).

Waste products from D&D activities would require disposal, and would add to existing waste accumulation, and to the environmental impacts associated with disposal facilities. Environmental releases of small amounts of residual tritium during D&D would not add measurably to current low levels.

Implementing the proposed TFTR D&D Project would represent a beneficial long term socioeconomic impact because the TFTR Test Cell Complex would be made available for other uses. This would eliminate the need to mothball TFTR (wasted land use) and would help maintain the current PPPL level of employment.

4.2 TPX Project

The estimated impacts of the TPX Project are presented in this section. As described in Section 2.2, the TPX design is based on the use of deuterium fuel, but it does not preclude the potential future use of tritium fuel. The use of tritium fuel was conservatively included in determining potential environmental, safety, and health impacts of the TPX project, in order to bound all modes of operation. The potential impacts of constructing and operating the possible upgrades discussed in Section 2.2.1.2 are bounded by the estimated impacts described in this section. Section 4.2.1 contains the expected impacts of TPX construction activities, and a discussion of the maximum anticipated impacts of TPX operation is given in Section 4.2.2. The discussion in Section 4.2.2 generally assumes that normal TPX operations exist (rather than abnormal or accident conditions), established TPX Project procedures are adhered to, monitoring and mitigative measures function as designed, and all Federal, state and local regulations are followed. Section 4.2.3 discusses potential impacts resulting from abnormal TPX operations and accidents. A brief discussion of TPX D&D impacts is given in Section 4.2.4. Sections 4.2.5, 4.2.6, and 4.2.7 summarize unavoidable adverse impacts, irreversible and irretrievable commitments of resources, and cumulative and long term effects, respectively.

4.2.1 Impacts of TPX Construction

This section addresses potential construction impacts associated with the proposed PPPL site and the alternative site. TPX construction includes Test Cell modifications and construction of the cryogenic equipment building, tank yards, and electrical substation. No adverse impacts are expected to occur to the local terrestrial ecology (including threatened and endangered species because none are known to occur at or near either construction site). Similarly, no historical or archaeological resources

are known to occur at either site. Construction would not impact local land use outside PPPL or the

visual appearance at either site, because both sites are currently committed to energy-related projects.

Construction would have a slightly positive socioeconomic impact at either site due to a modest demand for construction workers. No construction impacts would result from the no-action alternative.

Land Use. Construction required for the proposed TPX Project would involve using some existing open space at PPPL for several new facilities. The cryogenic building, tank yards and new electrical substation would all be built within D-site at PPPL, on land already committed to DOE operations. This construction would all be within the current land use restrictions governing the PPPL site agreements with DOE.

The new transmission lines required between the existing C-site substation and D-site to provide 138 kV power to the new D-site substation would be strung overhead, between two existing towers. This would all be done entirely on PPPL property, and would not affect any floodplains or wetlands and would not change any current PPPL land use.

If available TPX upgrade options are implemented, the existing incoming utility power line conductor would have to be replaced by the utility with a larger conductor (Section 2.2.1.2). This would not require construction of any new transmission towers or any construction outside the existing PPPL substation. This work would result in no changes to current land use, including any impacts to floodplains or wetlands, and would result in only minimal and temporary disturbance of the area immediately surrounding the towers. PSE&G would follow their internal procedures regarding coordination with the State for any required environmental permits for this utility maintenance operation.

Excavated soil from TPX construction sites would be temporarily stockpiled at acceptable sites near the construction sites. These stockpiles would be used for backfill or grading after completion of construction. No construction impacts would result from the temporary stockpiles of excavated soil.

Air quality. Low levels of fugitive dust and vehicle emissions would occur during TPX construction. Fugitive dust emissions would be controlled or reduced by mitigative measures as necessary (such as water sprinkling) to avoid excessive airborne dust. Construction vehicle emissions would be similar to those from other moderate construction projects of similar size and scope, which

do not present excessive levels. Emissions produced at the construction site from heavy equipment

are not regulated by New Jersey or Tennessee. No long-term measurable increase in either the fugitive dust or vehicle emissions are expected at either the PPPL site or the ORR site. However, emissions at the ORR site would be slightly greater due to the increased construction activities necessary for this site.

Noise. Noise levels at either site would increase during the construction period (mid-1997 through 1999). Noise levels would probably be highest during heavy equipment use (approximately a 7-month duration) and would be unnoticeable after excavation, concrete emplacement, and backfilling were complete. Noise might temporarily disturb PPPL or ORR employees, depending on the daily schedule of construction activities. Employees at both sites are accustomed to some construction activities, construction activities at PPPL in past years have not presented noise problems, and the noise accompanying these activities is an accepted occasional nuisance. The general public should not be disturbed, due to minimal noise and the distance of the general public from the site [minimum of approximately 350 m (1,150 ft)] at PPPL. No noise-related impacts for either site are expected offsite due to the buffer zone provided by the trees and the distance to the site boundary. The appropriate provisions of the New Jersey Administrative Code (Title 7, Chapter 29: Noise Control) would be adhered to.

Water quality and quantity. During the TPX construction period, an occasional temporary increase in sediment loading and siltation of Bee Brook (PPPL) or Poplar Creek (ORR) might occur following storms because of erosion from the site. The majority of any erosion would be controlled and any adverse effects would be minimized by measures discussed in Section 2.2.1.5, i.e., use of detention basins to partially settle particulate run-off and careful selection of stockpile locations. The sumps currently dewatering the TFTR site would continue to be used for the TPX Project.

Stream, groundwater, and soil deposition of some chemical substances used during construction (e.g., petroleum products and concrete additives) are also possible at either site. Effects from potential chemical spills at either site would be minimized and mitigated by appropriate containment and clean-up of spills (Section 2.2.1.3). PPPL has a Spill Prevention Control and Countermeasures Plan (Pirnie 1992) in place for control and cleanup of inadvertent spills. Potential spill size due to small quantities of chemicals and generally low toxicity of chemicals to be used are such that no measurable adverse effects to water quality from the construction are anticipated.

The ORR site might require sump pumps to eliminate potential groundwater seepage problems into the excavation. The amount of pumped water would likely be less than 1% of Poplar Creek's average flow rate and therefore no hydrologic impacts are expected.

Aquatic ecology. Construction may result in a temporary increase in site erosion, which represents a potential minor impact to aquatic ecology in Bee Brook or Poplar Creek. Proposed mitigative best construction management practices discussed in Section 2.2.1.5 (and under Water Quality and Quantity, above) would reduce the potential for erosion and associated impacts to the aquatic ecology at either site. Based on previous construction activities, any erosion resulting from TPX construction activities would not be expected to alter current sediment conditions in either Bee Brook or Poplar Creek. Any impacts would be of short duration and would not permanently affect the aquatic environment at either site. Minor contaminant and sediment loading similar to what already occurs without apparent effect would not represent an unusual occurrence for Bee Brook, Poplar Creek, or Clinch River, and would not alter the current status of these waters. Recommendations and precautions given by the U.S. Fish and Wildlife Service (see Section 7), as well as requirements of the PPPL NJPDES surface water permit, would be integrated into project plans, to protect and maintain the water quality of Bee Brook (see also Section 2.2.1.5 regarding construction practices).

Construction accidents. A construction project of this scope has a potential for worker injuries. Based on DOE averages, there would be an estimated two-and-a-half lost work cases (a) (LWCs) over the facility construction period at the PPPL site, or less than one LWC per year of construction. This LWC estimate would be slightly greater for the ORR alternative because of increased construction activities required for the ORR site.

It is estimated that less than 100 additional cars and trucks would be moving on and off the site daily during the construction period. This would represent roughly a 10% increase in the current amount of site traffic at PPPL (approximately a 5% increase for the ORR site) and would increase the potential for onsite vehicular accidents. Onsite traffic control and scheduling of traffic flow would reduce the potential for accidents to minimal levels. Offsite traffic flow and accident rates along U.S. Route 1 at PPPL or at the ORR site should not be adversely impacted from construction activities because the additional construction traffic would represent a very small (<1%) fraction of local offsite traffic.

Radiological impacts associated with construction. Soils that would be disturbed during

construction activities are not expected at the present time to be contaminated with radioactive material; if any such soils are found to contain radioactive material, they would be managed in accordance with NJDEPE and relevant Federal requirements. There would be no radiation or radioactive materials associated with TPX construction; however, residual sources of radiation within the TFTR test cell would present a potential source of radiation exposure to TPX construction workers. The expected radiation level from residual TFTR sources is estimated to be approximately 0.1 mrem per hour within the Test Cell, and radiation doses received by TPX construction workers would be 200 mrem per year or less (based on a 2,000 hour working year). This occupational dose would result in an increased probability of health effects of 8×10^{-5} . Applicable radiation protection standards for subcontractors to a DOE contractor are contained in DOE Order 5480.11; the appropriate DOE annual EDE limit would be 5 rem, although PPPL currently imposes a more restrictive administrative limit of 1 rem per year. Although the radiological conditions at the specific alternate site for TPX at ORR have not been characterized, the potential radiation doses of TPX construction workers at ORR would likely be less because no sources of measurable radiation have been identified that construction workers would be exposed to.

a LWCs are lost work day plus restricted work day cases. A lost work day is a day an employee is absent from work because of an injury at work. A restricted work day is a day an employee is present at work but restricted from normal activity because of an injury at work.

4.2.2 Impacts of Normal TPX Operation

The following subsections address the maximum potential environmental impacts expected from normal operation including potential upgrades of the TPX facility at either the PPPL site or the ORR site. The no-action alternative would not result in any impacts at the ORR site, and any impacts at PPPL would depend on the alternative selected for TFTR D&D (Section 2.1). Proposed TPX operations would have no adverse impacts in the areas of noise, terrestrial environment (including threatened and endangered species, and wetlands), visual environment, aquatic ecology, and historical resources. Proposed TPX operations would present the potential for essentially the same impacts as TFTR operations have had, and would not represent a change from the existing conditions at PPPL. Some impacts would occur in these areas of potential impact for the ORR site alternative (e.g., visual

environment), however any such impacts are not likely to be detrimental to the existing environment.

None of the proposed upgrades would cause changes in the bounding effects discussed for the baseline

D-D operations or for the D-T upgrade operations.

4.2.2.1 Nonradiological Impacts of Normal Operation. Air Quality. Nonradioactive atmospheric releases at either PPPL or ORR would include vehicle emissions, fuel combustion products from the TPX facility's share of the site's boiler use, and water vapor from the cooling towers. A small increase in heated floor space would result in a very small increase (less than 3%) in PPPL natural gas consumption (and resulting released combustion products) over present consumption.

Although no conflicts are anticipated, a review of existing PPPL Clean Air Act permits may be required. The more extensive new building at ORR would require a larger increase in heating requirements. Water vapor (fog) releases from the cooling towers during TPX operation would be about the same as for TFTR operation. Because of modest releases and adequate atmospheric dispersion in the past, there is no record of cooling tower water vapor releases causing fogging in any surrounding area. No adverse environmental impacts from nonradioactive atmospheric releases are expected at either site.

Water Quality and Quantity. Nonradioactive liquid effluents would consist of site surface water runoff, sump pump water, and cooling tower blowdown water that would be released to Bee Brook (PPPL) or Poplar Creek (ORR). Sanitary and nonhazardous chemical discharges would occur into the existing sanitary waste water system as permitted, or otherwise handled as appropriate. Use

of hazardous chemicals (e.g., sodium hypochlorite) is expected to be minimal, as is currently the case

for TFTR. Handling and disposal procedures of these chemicals would adhere to all applicable Federal, state, and local regulations and would not constitute a potential environment impact.

Blowdown water, sump pump water, and runoff from TFTR operations at the PPPL site are currently discharged to Bee Brook with little or no adverse impacts (Finley and Stencel 1992). Since

sump pump water is the largest contributor and will continue, TPX effluent discharges are expected to

be similar. Therefore, no detrimental effects from thermal properties of the TPX effluent are expected. The increase in effluents at the ORR site from TPX operation would be negligible relative

to the flow rate of Poplar Creek and to current discharges from ORGDP (DOE 1979, Oakes et al. 1987); therefore little or no incremental impacts are expected. No required modifications to current

PPPL or ORR permits issued under the National Pollutant Discharge Elimination System are anticipated.

Land Use. Operation of the TPX facility would eventually require land for disposal of waste.

Sanitary waste generation would not be different from current volumes generated at PPPL. The hazardous and radioactive wastes generated during TPX operation would have to be transported for disposal offsite. The volume generated would be small (approximately 10 to 30 m³ per year) (see Section 2.2.1.4) and would not adversely impact offsite disposal facilities (e.g., the disposal facility at

the DOE Hanford site) because the volume would be a small fraction of the disposal facility's multimillion cubic meter capacity, and it would not be an increase over current levels generated at

PPPL and shipped for disposal at Hanford. A similar amount of land disposal capacity would be required for hazardous and radioactive wastes generated at the ORR site alternative.

Socioeconomic Environment. Operation of the TPX facility at PPPL would require approximately the same number of employees required for TFTR (approximately 220). When TFTR is decommissioned, most of the PPPL employees would likely be reassigned to the TPX.

Assuming that there is essentially no change in work force or operating processes, there would

be no change in requirements for most of the utility systems for PPPL, including potable and nonpotable water, natural gas, solid nonradioactive and nonhazardous waste collection, sanitary waste,

and storm sewer systems. TPX would require more electrical power from the local utility than TFTR.

For D-D operation, the TPX electrical power demand is expected to be within the limits of the transmission lines currently in place at PPPL (138 kV to the PPPL substation). If all upgrade options

are implemented, the demand would be higher than initial demand, however use of a switched shunt capacitor power factor correction or replacement of a component at the PPPL substation, and installation of larger conductors on the incoming power lines, would allow the modified transmission

lines to be used (PSE&G 1993). Therefore, TPX electrical power consumption would not have an adverse effect on the electrical supply system for the PPPL site or surrounding area.

At the ORR site a population increase resulting from new employees would increase the demand for local services and schools, although none of the increases would exceed those associated

with previous levels of ORR operation. The general economy of the area could improve because of the influx of jobs. All of the utility systems at ORR could accommodate the TPX Project, with some

modifications. Other utility users would not be affected by the project.

The no-action alternative or the ORR site alternative would result in the eventual loss of those

jobs currently associated with TFTR. The current concentration of fusion research scientists and engineers would leave the PPPL site for work at other locations. There would be a slight decrease in

traffic on Route 1.

4.2.2.2 Radiological Impacts of Normal Operations. Estimated annual radiation doses resulting from normal releases during TPX operation at PPPL or ORR to the public (both for individuals and for populations) and workers are summarized in the following subsections. The term

dose as used in this EA refers to the EDE unless otherwise stated. Doses and health effects resulting from 1 year of D-D and 1 year of D-T operation are given in this section. Cumulative doses

and health effects resulting from 10 years of TPX operation are discussed in Section 4.2.7.

Major assumptions used to calculate doses are identified or referenced. A summary of potential radiological doses for the PPPL site is given in Table 4-2. Radiological consequences of the ORR site

alternative, if different from the PPPL site, are discussed as appropriate in the text. No TPX radiological impacts would result from the no-action alternative.

The TPX Project has adopted a design objective dose of 10 mrem per year as a maximum allowable individual dose to any member of the public (PPPL 1993b). Dose estimates contained in the following subsections show that this design objective would be met at either PPPL or ORR, for both D-D and D-T operations. A dose rate of 10 mrem per year represents approximately 10% of the 100 mrem per year that a member of the public receives at either site (exclusive of radon) from annual natural background radiation, and approximately 3% of the total [natural (including radon) and man-made] average annual background dose rate in the U.S. of 300 mrem per year (NCRP 1987).

Table 4-2. Maximum calculated radiological doses to a hypothetical member of the public from normal operations of the TPX facility at PPPL, compared with design objectives and regulatory limits.

Exposure pathway	Limit and regulatory source	Design objective	TPX Project	
			Calculated impact (maximum individual)	
			D-D operations	D-T operations
Drinking water	2uCi/L (H-3) DOE Order 5400.5	0.2 uCi/L (a)	< 0.01 uCi/L (b)	< 0.01 uCi/L (b)

"	"	4 mrem/year EPA 40 CFR 141	-	0.02 mrem/year(b)	0.02 mrem/year(b)
Air		10 mrem/year (c) EPA 40 CFR 61	-	1.2 mrem/year (d)	4.6 mrem/year (c)
All Pathways		100 mrem/year DOE Order 5400.5	10 mrem/year	4.2 mrem/year (f)	9.6 mrem/year (g)

- a. This design objective is for tritium concentration in water discharged to the sanitary sewer system.
- b. Values calculated for water at the point of discharge to the sanitary sewer system, and based on a total annual release to the sanitary sewer of 1 Ci per year tritiated water (see Section 4.2.2.2.3).
- c. This limit is for a dose calculated for an individual at the residence, school, business or office having the highest effective dose equivalent to a member of the public.
- d. Dose is calculated for a hypothetical individual residing at the site boundary, and results primarily from an annual release of 300 Ci per year tritiated water and 61 Ci per year Ar-41.
- e. Dose is calculated for a hypothetical individual residing at the site boundary, and results primarily from an annual release of 500 Ci per year tritiated water and 601 Ci per year Ar-41.
- f. Sum of 1.2 mrem per year from airborne releases and 3 mrem per year from direct radiation.
- g. Sum of 4.6 mrem per year from airborne releases and 5 mrem per year from direct radiation.

Calculated individual doses are based on estimated radioactive releases, meteorology, distance of the individual from the source, and the potential pathways for released radioactive material to reach individuals. The primary potential exposure pathways to the public are via airborne releases (Section 4.2.2.2.1), and direct radiation (Section 4.2.2.2.2); other potential sources of exposure are liquid releases (Section 4.2.2.2.3), and radioactive wastes. The small quantities of radioactive wastes generated at the TPX facility would be collected, stored, packaged, and transported to the DOE site at Hanford, WA in accordance with appropriate DOE and DOT safety guidelines, and therefore would not present a potential for measurable exposure to workers or to the public during normal operations. Detailed assumptions and discussion of the dose calculations are contained in McKenzie-Carter and Anderson (1993).

The DOE dose limit for individual members of the public from all TPX sources would be 100 mrem per year; the applicable DOE individual dose limit for airborne releases only would be 10 mrem per year (DOE 1990).

Risk values for radiologically-related health effects resulting from population doses have been estimated by the ICRP (1977, 1991), the UNSCEAR (1982), and the National Academy of Sciences (NAS 1980; NAS 1990). Risk values established by the three groups are in fairly close agreement. Recently, the Nuclear Regulatory Commission (NRC) adopted the most recent risk estimates of the ICRP (1991) for exposures of workers and the general public. For this EA, the dose-to-risk conversion factors in ICRP-60 (ICRP 1991) were used to calculate health effects (fatal cancers) of radiation exposure. The numerical values used for estimating cancer deaths from radiological exposures are 500 cancer deaths (latent cancer fatalities) per million person-rem EDE (numerically equal to 5×10^{-4} deaths per person-rem) for the general population and 400 latent cancer fatalities per million person-rem EDE for workers (numerically equal to 4×10^{-4} deaths per person-rem). Population effects are expressed as the estimated number of fatal cancers in the population (above the normal incidence rate), and individual effects are expressed as the maximum increased probability of the death of an individual. A calculated probability of 1×10^{-6} , for example, can also be expressed as one chance in one million.

4.2.2.2.1 Airborne Releases The public could be exposed to small amounts of radioactive materials released during normal TPX operation (Section 2.2). Estimated releases and subsequent doses would be higher during the year of possible D-T operations than for other modes of operation including the potential TPX D-D steady-state upgrade. Details of the dose consequence calculations from airborne releases of activated air products are shown in Appendix A. Annual and cumulative doses from maximum potential D-D and D-T releases are presented in this EA. The computer code CAP88-PC (EPA 1991) was used to calculate radiological doses from maximum potential airborne releases from TPX. This dose assessment code is based on AIRDOS-EPA (Moore et al. 1979), another code sponsored by the Environmental Protection Agency. The dose pathways included in CAP88-PC are ingestion, inhalation, external exposure, and skin absorption of tritiated water vapor (HTO). Measured test data were used to derive a site-specific annual average air concentration ($\mu\text{Ci}/\text{m}^3$) at the PPPL site boundary (DOE 1992), which was factored into the calculations.

Individual Doses and Health Effects (Public). The calculated doses to a hypothetical maximally exposed member of the public from maximum TPX facility airborne releases at the proposed PPPL site are tabulated in Tables 4-3 and 4-4, for D-D and D-T operations, respectively. The dose calculations include an assumption that the individual resides and consumes food grown

at

the site boundary location of maximum potential exposure, with no allowance made for protective shielding which would be provided by a residence.

The maximum calculated annual dose resulting from airborne releases during normal TPX D-D operations is approximately 1.2 mrem. The annual tritium release assumed for D-D operations is

300 Ci per year, even though operation of the TPS could reduce this to approximately 1 Ci per year.

Assumed tritium releases account for approximately 80% of the total dose, and the majority of the remaining fraction is from external exposure to Ar-41. Other radionuclides contribute smaller additions. The increased probability of fatal cancer from an annual dose of 1.2 mrem is 6×10^{-7} per

year. The maximum calculated annual dose resulting from airborne releases during normal TPX D-T operations is approximately 4.6 mrem. External exposure to Ar-41 accounts for approximately one-half of the total dose, and tritium accounts for approximately one-third. Other radionuclides contribute

smaller additions. The increased probability of fatal cancer from an annual dose of 4.6 mrem is 2×10^{-6} per year.

Because of the greater distance from the TPX facility to the site boundary for the ORR alternative [approximately 4 km (2.5 mi), compared to a minimum of 125 m (410 ft) at PPPL], public

doses for the ORR site alternative would be much lower than for the proposed action. Based on the

distance to the ORR site boundary, (and the resulting increased dispersion of released radionuclides)

the potential dose to a hypothetical maximally exposed member of the public at ORR is estimated to

be less than 1 mrem per year for both D-D and D-T operations. Based on an annual dose of less than

1 mrem per year, the increased probability of fatal cancer from airborne releases at ORR would be less than 5×10^{-7} per year.

Collective Doses and Health Effects (Public). The collective doses (i.e., the total population

doses) resulting from TPX airborne releases during both D-D and D-T operations were estimated by summation of calculated individual dose estimates for members of the population within 80 km (50 mi) of PPPL. The total population dose rate resulting from airborne releases during D-D operations is 7.5 person-rem per year, and the calculated collective dose for D-T operations is 24 person-rem per year. These estimates are based on an estimated resident population for the year

2010 of 16,375,448 within an 80-km (50-mi) radius of the proposed PPPL site. Based on these

Table 4-3. Hypothetical maximum individual doses from annual operational airborne releases during D-D operations. (a)

Effective dose equivalent (mrem) by exposure pathway					
Nuclide	Inhalation(b)	Ingestion(c)	Air submersion	Ground surface exposure	Nuclide totals
Tritium (d)	0.17	0.79	0	0	0.96
Argon-41	0.0002	0	0.23	0	0.23
Nitrogen-13	0.0001	0	0.005	0.0003	0.005
Others (e)	< 0.0001	0	0.005	0.0004	0.005
Pathway Totals	0.17	0.79	0.24	0.0007	1.2

a. These estimated doses were calculated for a person assumed to reside at the location of maximum

potential exposure (on the site boundary).

b. This exposure pathway includes skin absorption of tritium.

c. Ingestion dose calculation assumes that the following proportions of foods consumed were grown

or raised at the dose location: Vegetables: 70%; Meat: 44.2%; Milk: 39.9% (EPA 1989).

d. Tritium releases were assumed to be in the oxidized (HTO) form.

e. Other radionuclides are N-16, S-37, and Cl-40.

Table 4-4. Hypothetical maximum individual doses from annual operational airborne releases during

D-T operations. (a)

Effective dose equivalent (mrem) by exposure pathway			
	Air	Ground surface	Nuclide

Nuclide	Inhalation(b)	Ingestion(c)	submersion	exposure	totals
Tritium (d)	0.29	1.32	0	0	1.61
Argon-41	0.002	0	2.22	0	2.22
Nitrogen-13	0.01	0	0.36	0.02	0.39
Others (e)	0.002	0	0.38	0.03	0.41
Pathway Totals	0.30	1.32	2.96	0.05	4.6

- a. These estimated doses were calculated for a person assumed to reside at the location of maximum potential exposure (on the site boundary).
- b. This exposure pathway includes skin absorption of tritium.
- c. Ingestion dose calculation assumes that the following proportions of foods consumed were grown or raised at the dose location: Vegetables: 70%; Meat: 44.2%; Milk: 39.9% (EPA 1989).
- d. Tritium releases were assumed to be in the oxidized (HTO) form.
- e. Other radionuclides are N-16, S-37, and Cl-40.

annual population doses, no resulting fatal cancers would be expected in the population surrounding PPPL from 1 year of normal TPX D-D or D-T operations (calculated numbers of fatal cancers are 0.004 for D-D operations and 0.01 for D-T operations). By using the estimated PPPL population dose rates, and ratioing the two populations surrounding PPPL and ORR, a conservative population dose rate of 1 person-rem per year or less has been estimated for the ORR site. Based on this maximum population dose rate, no health effects (less than 0.0005) would result from ORR TPX facility releases during D-D or D-T operations.

These dose rates represent less than 0.002% increases to the background dose rates received by the resident populations around PPPL and ORR [1,640,000 (excluding radon) and 280,000 person-rem per year, respectively]. By dividing the collective population doses by the number of people in each assessment area (PPPL and ORR), average individual dose rates to individual members of the public from airborne TPX facility releases were estimated to be approximately 0.001 mrem per year which would result in an increased probability of health effects of 5 10-10.

4.2.2.2.2 Direct and Scattered Radiation A small fraction of the energetic neutrons and gamma rays generated during TPX pulses would penetrate the shielded test cell and would constitute a potential dose pathway to the public. Additionally, activated components in the test cell could add to the direct radiation field. Appropriate safety analyses would be conducted to ensure that the storage of activated components removed from the test cell would not pose a hazard to workers or to the public.

Individual Doses and Health Effects (Public). Based on measurements made during TFTR operation (Finley and Stencel 1992) and an annual production of 6×10^{21} DD neutrons per year, the maximum annual dose at the TPX facility boundary during D-D operations is expected to be 3 mrem including the potential TPX D-D steady-state upgrade. Measurements made for TFTR are reasonable to use to estimate TPX facility boundary dose rates because of the similar design and operation of the two machines. The increased probability of fatal cancer from an annual dose of 3 mrem is 1.5×10^{-6} per year. For the potential year of D-T operation, estimates indicate that a direct dose rate less than 5 mrem per year at the location of greatest potential public exposure would be achievable at PPPL (DOE 1992). An annual dose of 5 mrem would result in increased probability of fatal cancer of 2.5×10^{-6} per year. Lower dose rates (and individual risks of fatal cancer) would be achievable at the ORR site for either mode of operation because of the greater distance from the TPX facility to the nearest site boundary. If necessary, operation of the TPX machine could be controlled to limit dose due to direct radiation, or additional shielding could be provided.

Collective Doses and Health Effects (Public). Because the individual direct and scattered dose rate (a maximum of 5 mrem per year at the site boundary) would decrease rapidly with increasing distance (roughly as the square of the distance), the potential dose rate at the nearest permanently inhabited residence near PPPL [approximately 975 m (3,200 ft)] would be very small for either D-D or D-T operation (less than 0.1 mrem per year). Therefore, the potential total population dose within 80 km (50 mi) due to TPX pulses would also be very small. No resulting fatal cancers would be expected in the population surrounding PPPL from 1 year of normal TPX D-D or D-T operations. Because of the greater distance to a controlled area boundary at the ORR site, this conclusion is valid for the ORR alternative also.

4.2.2.2.3 Liquid Releases Small amounts of radioactively contaminated liquids might be released at low concentrations during normal TPX operations (Section 2.2). The most

significant of such releases would be the release of tritium-contaminated liquid to the sanitary sewer

system. The potential consequences of the maximum release allowed by the State of New Jersey (1 Ci per year) have been evaluated (McKenzie-Carter and Anderson, 1993), and were found to result

in a maximum dose of 0.02 mrem per year to any individual. This dose rate would be the maximum dose for either D-D or D-T operations, and is a fraction of the DOE and EPA drinking water dose limit of 4 mrem per year given in DOE Order 5400.5 (DOE 1990) and 40 CFR 141. An annual individual dose of 0.02 mrem per year would result in an increased probability of fatal cancer of 1 10^{-8} per year.

A potential dose for the ORR alternative would be small and comparable to that of the PPPL site,

and thus liquid releases are anticipated to be a very small contributor to the radiological impacts of

TPX normal operations. Appropriate release limits would be adopted at the ORGDP site so that any resulting dose from liquid radioactive releases from the ORGDP TPX facility would be within applicable limits.

4.2.2.3 Occupational Impacts of Normal Operations. Occupational Radiological Doses.

Low doses to workers within the PPPL site from exposure to airborne releases, direct and scattered

radiation, and radioactive waste are expected, but would be controlled and maintained below PPPL administrative limits (1,000 mrem per year, 600 mrem per quarter). Airborne tritium levels throughout

the facility would be monitored, and routine occupational exposures to tritium would be minimal.

Direct and scattered radiation present during maintenance activities would constitute the primary source of occupational exposures. Detailed designs are not yet complete, therefore potential occupational doses from direct and scattered radiation have not been rigorously estimated for the TPX.

However, occupational exposures during TFTR D-T operations have been evaluated, and found to be controllable to within PPPL limits for occupational exposures (DOE 1992). Furthermore, experience gained during TFTR D-T operations will add confidence to this assessment. The occupational impacts

for the ORR site alternative would be the same as for PPPL, and no impacts would result from the no-action alternative.

Non-ionizing radiation exposure to workers would also be a possible consequence of the proposed

action and the ORR site alternative. Radio-frequency surveys and magnetic field mapping would be performed to characterize potential exposures. During TPX operation, access to areas that could be

subjected to non-ionizing radiation would be restricted or prevented as necessary to ensure worker

safety. Access restrictions would be accomplished through the use of engineered features (e.g., interlocking of source operation with entrance doors), and by administrative controls (e.g.,

personnel

training, signs, etc.). These measures are currently used for PPPL operations. Hazards of non-ionizing radiation have been evaluated in the TFTR Final Safety Analysis Report (PPPL 1992b).

Nonradiological Occupational Impacts. Operation of the TPX would not result in any unusual nonradiological impacts to TPX workers or other non-TPX PPPL employees. The project would present routine industrial hazards (e.g., confined spaces, high voltages, pressurized systems), such as are present during current TFTR operations. These hazards would easily be managed via standard safety, engineering, and administrative controls. The TPX Final Safety Analysis Report, which would be prepared prior to initiation of TPX operations, would address occupational hazards and their mitigation.

4.2.3 Impacts of Abnormal TPX Operations and Accidents

Four general categories of events have been identified for the proposed TPX project that could result in the accidental release of radioactive materials: (a) natural phenomena (Section 4.2.3.1), (b) accidents with external origin (Section 4.2.3.2), (c) shipping accidents (Section 4.2.3.3), and (d) operational occurrences (Section 4.2.3.4). Potential occupational doses are discussed in Section 4.2.3.5 and accidents involving nonradiological impacts are discussed in Section 4.2.3.6. Discussion here is generally limited to those accident scenarios classified as design basis accidents (i.e., having a probability of occurrence equal to or greater than 10^{-6} per year, or one occurrence in a million years) (Elder et al. 1986). Events that would be most likely to occur and those whose consequences would be most serious are emphasized. DOE (1992) gives a complete discussion of the potential radiological consequences of various accident scenarios for the TFTR D-T operations. Most of that discussion is directly applicable to TPX D-T operations. Further, TFTR abnormal and accident analyses were used to bound TPX operations, except in those cases where there are differences that may result in adverse consequences (Schmidt 1993). The no-action alternative would result in no impacts, and the alternative siting at the ORR would result in impacts comparable to the TPX project as proposed at PPPL.

All calculated accident doses are based on the dispersion values obtained from the NOAA dispersion tests (NOAA 1989, DOE 1992). McKenzie-Carter et al. (1991) gives a description of the methodology used to calculate individual and collective doses. Unless otherwise stated, all accident

doses given are effective dose equivalents. Collective doses in the EA are based on the projected

population for the year 2010, and include the ingestion pathway for crops, milk, and beef, assuming

that the productivity values of the land for these foods are the average values for the State of New

Jersey. This is a conservative assumption because the area within 80 km (50 mi) of PPPL is more industrial than agricultural in nature and would have lower productivity values than the state average.

The proposed operational plan for TPX is approximately 9 years of D-D operations with a potential for 1 year of D-T operations during the tenth year. If D-T operation occurs, the maximum

releasable tritium inventory in any one place would be about 25 kCi (Cadwallader and Motloch 1993).

In contrast, for D-D operations there is no process tritium. However, a byproduct of the D-D reaction

is tritium and it has been calculated that less than 300 Ci per year of tritium would be produced during the 9 years of D-D operations (Fleming 1993). If all this were stored for the 9 years of D-D

operations, the maximum total inventory of tritium would be less than 2,700 Ci. This is about 10% of

the 25,000 Ci releasable tritium inventory assumed for DT operations. Thus D-T accident scenarios

discussed in this EA including postulated shipping accidents, provide an upper bound of the consequences of abnormal TPX operations and accidents.

The site boundary dose resulting from the unmitigated ground-level release of the maximum inventory of activated air at the end of a D-D pulse would be about 0.1 mrem with an increased probability of health effects of 5.0×10^{-8} . This can be compared to about 1 mrem at the end of a D-T

pulse (see Appendix D) with a corresponding increased probability of health effects of 5.0×10^{-7} .

And, the site boundary dose resulting from the unmitigated stack release of the maximum inventory of

releasable activated solids at the end of D-D operation would be about 2.5 mrem resulting in an increased probability of health effects of 1.3×10^{-6} . This can be compared to a dose of about 50 mrem at the end of D-T operations (Cadwallader and Motloch 1993) which corresponds to an increased probability of health effects of 2.5×10^{-5} . For comparable scenarios, health consequences

can be scaled based on the amount of tritium, activated air, and activated solids released. Therefore,

the health consequences from postulated D-D operations accident scenarios would be a fraction of the

health consequences from the corresponding postulated D-T operations accident scenarios.

One of the proposed TPX upgrades is steady-state D-D operation for up to 200,000 seconds. The maximum site boundary dose resulting from the unmitigated stack release of the maximum releasable

inventory of activated solids at the end of the steady-state D-D upgrade would be about 8 mrem which

is bounded by the D-T operations postulated accident scenarios

The estimated probabilities for abnormal events and accidents given in this section of the EA are

conservative upper-bound, order-of-magnitude estimates, based on documented information where available (Cadwallader and Motloch 1993). Where specific documented information was not available

or applicable, estimates were based on engineering judgment, using information for similar systems if

possible. The most significant accident scenarios are summarized with their frequency and dose consequences in Table 4-5. Appendix B contains additional information on TPX accident scenarios.

As the TPX design matures, additional safety analyses would be performed and documented in the TPX Final Safety Analysis Report. All analyses reported in this document are conservative and upper-bound.

4.2.3.1 Natural Phenomena. Natural phenomena, such as storms, floods, earthquakes, etc., have been studied for the PPPL site (DOE 1992). Given PPPL's robust construction and geographic high ground location, there are no credible natural phenomena that could cause accidental releases at

TPX.

4.2.3.2 Accidents with External Origins. Explosions or releases from nearby industrial facilities, transportation accidents involving radioactive or hazardous materials, dam failures, airplane

Table 4-5. Summary of accident scenarios and their radiological consequences.

Scenario description	frequency (per year)	Release and form	Maximum individual dose (mrem) and health effects at the site boundary	Population (person-total health effects)
A line break external to the tritium storage bed which contains pyrophoric uranium allows air to enter and react with it. The function of the uranium is	10 ⁻⁵	25kCi tritiated water vapor	140 7.0 X 10 ⁻⁵	1,710 8.6 X 10 ⁻¹

to chemically bond with tritium and thus to act as a storage medium. The reaction drives gases back out of the break, releasing contents in water vapor form. The vault fails to isolate, and the effluent is released through the roof vent.

Ex-vessel water leak, plasma heats walls, tubes fail, hydrogen generation, plasma disruption, and hydrogen explosion. Vacuum vessel break to test cell, so tritium, dusts, and activated air are all released from the roof vent.	10 ⁻⁵	20kCi tritiated water vapor	112 5.6 X 10 ⁻⁵	1,368 6.8 X 10 ⁻
		0.019 Ci activated titanium alloy	0.009 4.5 X 10 ⁻⁹	(b)
		2.5 Ci N-13	0.07	(b)
		0.7 Ci S-37	3.5 X 10 ⁻⁸	
		3.2 Ci Cl-40		
		1.8 Ci Ar-41		
		Total	112.1 5.6 X 10 ⁻⁵	1,368 6.8 X
10 ⁻¹				

Severe plasma disruption releases 50 g of vessel wall material. Disruption also breaches the vacuum vessel. The breach adds the 200 g of tokamak dust to the releasable inventory. The HVAC system HEPA filter is available (a). The material is released through the roof vent.

Magnet arc vaporizes Incoloy 908 magnet stabilizer and 231 kg of Incoloy 908 is mobilized. Cryostat is breached. The HEPA filters in the HVAC system can reduce the release through the roof vent (a).	(c)	91 Ci activated Incoloy 908	5 2.5 X 10 ⁻⁶	2.19 1.1 X 10 ⁻³
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Activated N-13 leaks from the cryostat pipes or cryo-panels into the test cell. The 0.07 Ci of cold N-13 entrains activated air and exits from the roof vent, then settles as a ground level release at the site boundary.	3 X 10 ⁻³	2.57 Ci N-13 0.7 Ci S-37 3.2 Ci Cl-40 1.8 Ci Ar-41	0.2 1.0 X 10 ⁻⁷	(b)
A magnet movement event, steam ingress event, or severe disruption releases a combined inventory. The vacuum vessel is breached resulting in graphite reactions and a tritium release. 200 g of activated dusts are released, 231 kg of Incoloy 908 are released in a magnet arc, 50 g of disruption dusts are released, and the activated nitrogen and other gases vent to the test cell. The HVAC runs. The HVAC HEPA filters are available to trap activated solids (a). The combined inventory is released through the roof vent	(c)	20kCi tritiated water vapor 0.019 Ci activated titanium alloy 0.07 Ci N-13 and 1.8 Ci Ar-41 gases 91 Ci activated Incoloy 908 Total	112 5.6 X 10 ⁻⁵ 0.009 4.5 X 10 ⁻⁹ 0.07 3.5 X 10 ⁻⁸ 5 2.5 X 10 ⁻⁶ 116 5.8 X 10 ⁻⁵	1,368 6.8 X 10 ⁻¹ (b) (b) 2.19 1.1 X 10 ⁻³ 1,370 6.8 X 10 ⁻

Notes: See McKenzie-Carter et al. (1991) for dose calculation methods. The maximum individual doses are whole body, 50 year committed values. DOE Order 6430.1A (DOE 1989) gives a 50 year committed whole body dose siting guideline of 25 rem (or an EDE of 25 rem) for accident situations. All gas activities are based on D-T pulses. All metal activities are based on end of D-T operations.

- a. HEPA filtration is accounted for, as is permissible in Elder (1986), but was not given full efficiency to be conservative. Filtration efficiency of 90% was used as in the SIS EIS (1988).
- b. Negligible population dose, less than 1 person-rem.
- c. The probability is in the extremely unlikely events category, i.e., 10⁻⁴ per year to 10⁻⁶ per year.

crashes, etc. are not considered here because the likelihood of such events occurring and causing damage to the TFTR has been shown to be less than 1 10⁻⁶ (Holland et al. 1991).

4.2.3.3 Shipping Accidents. Tritium would be shipped for the TPX project only if the 1 year of D-T operation occurs. The majority of tritium shipments [approximately eight (four in each direction) over the 1-year period, assuming utilization of a TPS or approximately 100 (50 in each direction over the 1-year period if a TPS is not utilized)] would be made in Type B shipping containers meeting DOE requirements. The Type B containers would be filled with a maximum of 25 kCi of tritium. The tritium inventory limit for the TPX Project would be established during the design stage and would be controlled throughout the TPX Project lifetime by means of an appropriate document approved by DOE. This would limit the total amount of tritium in onsite components of the TPX Project. An equivalent amount of tritium bearing waste would also be removed. The probability of an accidental release of radioactivity from these containers would be small because of the integrity of the Type B containers.

It is anticipated that tritium would be delivered to TPX from the Savannah River Plant in South Carolina or from the Tritium Systems Test Assembly (TSTA) at the Los Alamos National Laboratory (LANL) in New Mexico. Recently, the state of New Jersey was consulted and had no objections regarding tritium shipments for TFTR D-T operation. In this case, tritium was flown from TSTA to Mercer County Airport and then trucked to PPPL. A more recent shipment was trucked from TSTA to PPPL. The limiting criteria for shipping accidents would be the number of trucking miles through urban areas. Of the two choices, shipments from the Savannah River Plant would result in the highest miles through urban areas.

If tritium is trucked the 1,610 km (1,000 miles) from the Savannah River Plant to PPPL and trucked as waste to the Hanford site in Washington state (4,242 km or 2,636 miles), a transportation package failure probability of 2.1×10^{-6} per trip from the Savannah River Plant and 3.5×10^{-6} per trip to Hanford [derived from Holland and Lyon 1989, using urban distances of 403 km (250 miles) for the trip from the Savannah River Plant and 682 km (424 miles) for the trip to Hanford as determined by using state maps](a) would apply. In this case, the probability of any release of tritium during a shipping accident would be less than 3×10^{-5} per year. If a TPS can not be used, and assuming a total of 100 tritium shipments over the 1-year period [similar to assumptions for the TFTR DT program in DOE (1992)], the probability of a tritium release during a shipping accident would be less than 3×10^{-4} per year. The transportation routes available for trucking tritium to and from PPPL offer options to bypass major population centers to further minimize the public risk (e.g., DOE 1992, Section 2.1.1.6). The routes ultimately used would be chosen in consultation with the State of New Jersey. Thus, the transportation of tritium is expected to present little potential for public

hazard.

a The accident data base associated with type B containers is too small to be statistically significant.

Therefore, the analysis was done using the accident data base for Type a containers. This yields conservative results because Type B containers are designed to be stronger than Type A containers (Cadwallader and Motloch 1993).

Low-activity shipments not using the Type B containers would use other DOT-approved packaging methods.

The activity level of the these shipments would be low enough that a release of the contents would not

create a radiological hazard. Thus the risk to the public and the environment from a transportation

accident is considered negligible.

4.2.3.4 Operational Occurrences. Accidental release of tritium or activated gases, liquids or structural material could result in public exposures. Other forms of accidental public exposure, e.g.,

direct radiation exposure and exposure from solid waste, are not discussed here because no reasonable

foreseeable events with significant consequences involving these forms can be postulated. The

existing TFTR facility Liquid Effluent Control System would be utilized for TPX and would not contain any significant radionuclide inventories except following a major accident. This system (see

Section 2.2.1.2 and DOE 1992, Section 2.1.2) includes three 15,000 gallon collection tanks located in

an enclosed, diked area (sized to retain the volume of all three tanks) and is designed to contain any

spills of radioactive liquids. Because of the low probability of an accident that could result in the

formation of large quantities of radioactive liquids, and the subsequent low probabilities of failures

which would have to occur before a release to the environment could occur, the release of a significant inventory of radioactive liquid waste is not considered credible. D-T operations are assumed for 1 year only, therefore the likelihood of occurrence is low.

4.2.3.4.1 Accidental Tritium Releases Tritium inventories at TPX are separated into physically isolated areas, with administrative limits of 25 kCi or less. Because the tritium would

normally be confined by multiple barriers, the probability of large releases to the environment are

small. Tritium-bearing components would be confined in gloveboxes or fume hoods. TPX Facility rooms containing tritium-bearing components would be maintained at negative pressure. Maximum individual dose calculations for accidental release scenarios involving elemental tritium assume that

one percent of the elemental tritium is oxidized to tritiated water during release and subsequent

dispersion. Corresponding collective population dose calculations assume total oxidation of released

elemental tritium to tritiated water.

Significant accident scenarios have been investigated by Cadwallader and Motloch (1993) and are

summarized with their frequency and dose consequences in Table 4-5. A more comprehensive discussion of tritium releases (the major concern) is provided in Appendix B. The most hazardous accident scenario is a release of 25 kCi tritium from the waste handling or a tritium storage bed(a) due

to equipment and glovebox or fume hood failure, with conversion to tritiated water vapor, and escape

through the building ventilation system due to ventilation isolation failure. The frequency of this

event is 10^{-5} per year, and the individual dose at the site boundary is 140 mrem, and the population

dose would be about 1,710 person-rem. The individual site boundary dose would result in an increased cancer probability of 7×10^{-5} . The health effects resulting from this population dose to the

most populated sector would be roughly one fatal cancer in a population of 2.8 million, which represents 0.6% of the health effects from the annual background EDE (exclusive of radon) of 280,000

person-rem. That dose is a small fraction of the DOE siting guideline of 25 rem. If D-T operation

occurs, it would only be for the last year of TPX operation.

4.2.3.4.2 Accidental Activated Gas Releases The activated air production by

neutrons created during TPX operation would be very low because of the neutron shield on the outer

surface of the vacuum vessel. Activated air releases are considered in the normal operations section

of this report. The only plausible off-normal event would be a ground level release of activated air

caused by a cryogen release in the test cell (Cadwallader and Motloch 1993). The gases exit from the

roof vent, but are assumed to sink to the ground for a ground level release. The site boundary dose

for such a release would be 0.2 mrem and the increased probability of fatal cancer would be 1×10^{-7} .

The frequency of this event is projected to be about 3×10^{-3} per year.

A leak from the cryostat cryopanel could vent into the test cell releasing the 0.07 Ci inventory of

N-13 and entrained activated air. A release through the stack would also result in a dose of 0.2 mrem

calculated as a ground level release to account for cold gas potentially settling to the ground. Since

these gases decay quickly, population doses would be negligible for each case and would result in no

excess health effects.

a Recent investigation into release of tritium from storage beds indicates that an air ingress accident

involving a TFTR storage bed would not result in a release of tritium (see Appendix B).

4.2.3.4.3 Accidental Solid Activation Product Release Sources of solid activated material

that could potentially be released include activated dust in the torus, activated impurities in the wall

of the torus, and activated magnet material. Off-normal events that could potentially mobilize this

material include: a magnet arc between leads; explosions resulting from hydrogen generation from water

reaction with graphite or beryllium; fire in the TPX test cell creating airborne dust and smoke; an air

break into the torus; and severe plasma disruptions.

4.2.3.4.3.1 Magnet Arc Between Leads The potential consequences resulting from a postulated

magnet arc between magnet leads has been evaluated (Cadwallader and Motloch 1993). The analysis conservatively assumes that all of the energy stored in the toroidal field magnets would be dissipated

in vaporizing activated Incoloy 908 magnet material that had been irradiated by the neutron flux from

the vacuum vessel after 10 years of TPX operation. The maximum resulting dose at the site boundary for

a roof vent release would be 5 mrem, and the collective dose would be 2.2 person-rem. The individual

site boundary dose would result in an increased probability of fatal cancer of 2.5×10^{-6} and the population dose would result in less than one fatal cancer in the exposed population.

The probability of occurrence of this scenario is expected to be no higher than in the 10^{-4} to 10^{-6}

per year frequency range. The probability of a release into the environment from this event is also

very low because of the effectiveness of the confinement and particulate filter systems. The potential

consequences have been estimated based on the maximum amount of material which could be

mobilized by this event without taking credit for natural removal by gravity settling, or deposition on

surfaces. The projected site boundary whole body dose from this event is a small fraction of the DOE

Order 6430.1A siting guideline of 25 rem. If the effects of the neutron shield system and natural

removal mechanisms were accounted for, the consequences of this event would be much lower.

Details of the analysis are provided in Appendix C.

4.2.3.4.3.2 Hydrogen Generation from Reaction with Graphite The

potential for hydrogen generation inside the vacuum vessel due to an endothermic reaction between water and a proposed graphite surface for the diverters and the first wall has been evaluated for in-vessel and ex-vessel loss of cooling accidents (Cadwallader and Motloch 1993). The postulated in-vessel accident would result from the rupture of either a cooling tube, header, inlet pipe, or outlet

pipe. This accident would release cooling water inside the TPX vacuum vessel during plasma operation. The result would be an immediate plasma disruption, and graphite-water reaction. The more severe postulated ex-vessel loss of cooling accident would release cooling water outside of the

vacuum vessel, leaving the diverter and first wall structures without cooling. Under these conditions

for the ex-vessel accident, and assuming continued plasma operation, the diverter and first wall would

be heated to temperatures that exceed tubing material melting temperatures, causing an in-vessel cooling system failure, a cooling water leak, and graphite-water reaction.

The study shows that the amount of hydrogen generated by the TPX diverter structure during loss

of cooling accidents would result in a maximum hydrogen concentration of 6%. While this is above the ignition threshold for hydrogen-air gas mixtures (4%), it is below the detonation threshold (13.6%)

for a volume the size of the TPX vacuum vessel. In addition, the TPX would have an active plasma interrupt system designed to avoid thermal damage to the diverter during accidents. If the response

time of this interrupt system is less than 5 seconds, the amount of hydrogen generated during ex-vessel accidents would be less than the ignition concentration of 4%. Failure of the interrupt

system must also be considered, but its failure probability also reduces the accident scenario frequency

of occurrence.

The amount of hydrogen that could be generated by the TPX first wall during ex-vessel loss of cooling accidents is a potential safety concern since the amount of hydrogen generated could exceed

the detonation threshold for a volume the size of the TPX vacuum vessel. This accident would release

20 kCi of tritiated water, 0.019 Ci of activated titanium alloy, plus activated air in the test cell

including 2.5 Ci of N-13, 0.7 Ci of S-37, 3.2 Ci of Cl-40, and 1.8 Ci of Ar-41. The maximum individual dose at the site boundary would be 112 mrem and the population dose would be

1,368 person-rem. The health effects resulting from these doses would be an (individual) increased

probability of fatal cancer of 6×10^{-5} and less than one fatal cancer in the exposed population. These

doses and health effects would be possible only during the year of D-T operations. The doses and health effects for the 9 years of D-D operation would be a fraction of a percent of the D-T values

because of the much smaller amount of tritium present during D-D operations. The loss of cooling accident scenario has a frequency of 10^{-5} per year. To alleviate this potential concern, design steps would be taken to ensure that temperatures in the tiles are sufficiently low to preclude hydrogen levels above detonation thresholds, and an active plasma interrupt system would initiate rapid plasma discharge termination. These features would reduce the probability of occurrence and reduce the dose consequences.

4.2.3.4.3.3 Hydrogen Generation from Reaction with Beryllium

The potential for hydrogen generation inside the vacuum vessel due to an exothermic reaction between water and a possible future operation with beryllium-cladding for the diverters and for the first wall also has been evaluated for in-vessel and ex-vessel loss of cooling accidents (Cadwallader and Motloch 1993). One thousand kilograms of beryllium were assumed to be bonded evenly on the surfaces of the diverters and first wall. A model similar to that used for the graphite-hydrogen study was used with appropriate changes to account for the beryllium.

Calculations show that the postulated in-vessel loss of cooling accident cases are not a safety concern for the beryllium coatings because the plasma disrupts at the start of the transient, and the generated hydrogen (0.0003 kg) would be less than 1% of that necessary for ignition (0.3 kg) in the TPX vacuum vessel.

The postulated ex-vessel loss of cooling accident cases would require mitigating actions to prevent high levels of hydrogen, even though the postulated consequences are minor. Results show that the diverter could generate enough hydrogen to reach the ignition threshold after 60 seconds and the first wall after 350 seconds. This accident would release similar radiological inventories and have a similar frequency as the reaction with graphite and would have the same consequences; the maximum individual dose would be 112 mrem and the population dose would be 1,368 person-rem. The health effects resulting from these doses would be an (individual) increased probability of fatal cancer of 6×10^{-5} and less than one (0.7) fatal cancer in the exposed population. Thus, to avoid conditions of concern regarding hydrogen generation by the diverter and first wall, design steps would be taken to ensure that a plasma interrupt system would initiate plasma termination in less than 60 seconds following an ex-vessel loss of cooling accident. Associated releases of beryllium and their potential impacts to the public are addressed in Section 4.2.3.6.

4.2.3.4.3.4 Fire in the TPX Test Cell The potential for a conventional

fire in the TPX test cell that could volatilize activated solid material has been evaluated (Cadwallader

and Motloch 1993). The study concludes that the probability of a fire in the TPX test cell is low, i.e.,

5 10⁻³ per year, and that the maximum possible temperature (1,050C) that could be generated by fire with a dispersed fuel source is not high enough to cause activated solid material to volatilize (e.g.,

titanium vacuum vessel melting point is 1,670C) even if the fire could penetrate the surrounding cryostat.

4.2.3.4.4 Beyond Design Basis Accidents This section is included to evaluate events that

are beyond the design basis, i.e., Beyond Design Basis Accidents (BDBAs), events which are reasonably

foreseeable for which the impacts have catastrophic consequences, even if their probability is low, but

about which information is incomplete or unavailable. This analysis of the impacts is supported by credible

scientific evidence based upon theoretical approaches and research methods generally accepted in the scientific

community, is not based on pure conjecture, and is within the rule of reason.

A number of highly improbable BDBA scenarios have been postulated and evaluated (Cadwallader and Motloch 1993). The probability of occurrence of any of these scenarios is extremely unlikely, but bounding analyses have been performed to examine the potential consequences

of these accidents. The analyses shows that all of the BDBAs would be low-consequence events.

Further, the tritium accidents would only occur if tritium were used and would only be possible for

1 year. The accidents would have much lower consequences for D-D operations.

Several BDBA scenarios are discussed below:

- A leak occurs in the gas holding tank after a vacuum vessel helium-oxygen glow discharge cleaning operation. With 20 kCi of tritiated water in the tank, a leak occurs. The Torus Cleanup

System cannot maintain a negative pressure on the tank, and it vents to the tank room. Tank room isolation fails, and the ventilation fans also fail, so the tritium escapes from the building at

ground level. The tank failure rate is 0.01 per year, the probability that the TCS cannot maintain

negative pressure is 0.01 per demand, tank room isolation failure is 0.01 per demand, and the probability of the fans failing is the time period of interest is about 1 X 10⁻³ (This value is based

on a fan failure rate of 5 X 10⁻⁴ per hour 2 hours, the expected duration of the release. There

are no identified common mode failures for the fan to specifically fail when there is a tritium

release in progress). This release, with approximately a 1×10^{-9} per year frequency, results in a

site boundary dose of 314 mrem and an increased probability of fatal cancer of 2×10^{-4} . The population dose is 1,368 person-rem, which is approximately 0.5% of the background collective dose of 280,000 person-rem received annually by the potentially exposed population. This population dose would result in less than one fatal cancer in the exposed population. This is a low probability, low consequence accident.

- A leak [less than or equal to 1,000 cubic feet per minute (28 cubic meters per minute), the maximum processing rate of the leak mitigation system] occurs in the vacuum vessel boundary. The TCS and the TVCS (aligned to the vessel during tritium operations) fail to maintain the required inflow rate of 125 ft per minute of air into the break, resulting in a release of torus

tritium into the test cell. The stack fans also fail, resulting in a ground level release of 20 kCi of

tritiated water vapor. Based on review of operations and analyst judgment, such vacuum vessel leaks might occur at a frequency of 0.04 per year (Cadwallader and Motloch 1993). The TVCS failing is given a 0.01 per demand probability, and the probability of stack fan failure is 1×10^{-3} ,

as described above. Combining these values with the initiating event frequency of 0.04 per year

gives this BDBA a frequency of about 4×10^{-7} per year. The site boundary dose consequence is

314 mrem and the increased probability of fatal cancer is 2×10^{-4} . The population dose is 1,368

person-rem, which is approximately 0.5% of the background collective dose of 280,000 person-rem received annually by the potentially exposed population. Less than one fatal cancer would result from this population dose in the exposed population.

- A tritium storage bed, containing 25 kCi of elemental tritium, experiences an inleakage of air.

This event is assumed to be much more hazardous than tests indicate (Longhurst 1992). The air leaks in quickly, causing the bed to burn and oxidize the tritium. The tritium vault area does not

receive ventilation isolation, and the stack fan fails during the event. The tritium is released from

the building at ground level. The air inleakage frequency for this event is 1×10^{-4} per year,

isolation failure probability is 0.01 per demand, and the fan failure probability is 1×10^{-3} over the

duration of this event. The BDBA frequency is about 1×10^{-9} per year, with a site boundary dose of 393 mrem. The increased probability of fatal cancer from this individual dose is 2×10^{-4} .

The population dose is 1,710 person-rem, which is approximately 0.6% of the background collective dose of 280,000 person-rem received annually by the potentially exposed population. Roughly one fatal cancer would result from the population dose.

- The magnet arc between leads of superconducting magnet coils occurs, but in this case, the test

cell ventilation fan fails, leading to a building leakage (ground level) release of all of the volatilized, activated magnet material. The frequency of this event is very low, in the 1×10^{-4} to

1×10^{-6} per year frequency range, if it is credible at all. A coincident failure of the ventilation

fan at 1×10^{-3} probability (DOE 1992) would give an event frequency in the 1×10^{-7} per year

range or lower. Fan failure would result in a ground level release of the volatilized material.

The site boundary dose from this event would be 140 mrem, and the increased probability of fatal

cancer would be 7×10^{-5} . If plateout was accounted for, the effects of this event would be smaller. The population dose is 21.9 person-rem, which is approximately 0.008% of the background collective dose of 280,000 person-rem received annually by the potentially exposed population. The population dose would result in less than one fatal cancer in the exposed population.

- A leak [less than or equal to 1,000 cubic feet per minute (28 cubic meters per minute)] occurs in

the vacuum vessel boundary, at a frequency of 0.04 per year. The TCS or TVCS does not

actuate to mitigate the leak, with a 0.01 per demand failure probability. 20 kCi of tritiated water

vapor is assumed to escape from the vacuum vessel into the test cell. Then, an operator inadvertently switches the test cell HVAC system to complete recirculation mode [at 3×10^{-3} probability for error of commission (see Wilkinson 1991)], so the tritiated water released from the

vacuum vessel is condensed on the air conditioning coils and drained to the Liquid Effluent Collection Tanks. Then, a valve on one or more of the tanks is assumed to be inadvertently opened (again a 3×10^{-3} probability), discharging all of the tritium effluent to the sanitary sewer

system. The frequency of this BDBA event is about 4×10^{-9} per year. Since the water from the

PPPL sanitary sewer system is treated and then used as a backup water supply for the area population for a few hours per year, the estimated dose from this event is 0.5 mrem (DOE 1992)

and the increased probability of fatal cancer is 3×10^{-7} . The maximum collective dose would be

approximately 280 person-rem (DOE 1992), which is approximately 0.1% of the background collective dose of 280,000 person-rem received annually by the potentially exposed population. This population dose would result in less than one fatal cancer in the exposed population.

- Both test cell fans fail immediately after a full power D-T pulse. Then the test cell door interlocks fail, followed by personnel inadvertently opening the large exterior door in the Mock-

up Building portion of the test cell immediately after the pulse. It is conservatively

assumed that

the activated gases generated during a D-T pulse escape from the test cell directly as a ground

level release, without any dilution into the rest of the test cell air (DOE 1992). The dose from

this most conservative activated gas release event is 1 mrem at the site boundary (see Appendix

D), the increased probability of fatal cancer from this dose is 5×10^{-7} . The probability of this

scenario cannot be adequately quantified due to the combination of unrelated mechanical faults and unlikely human error, but it is much less than 1×10^{-6} per year.

Based on this analysis, it is concluded that there are no reasonably foreseeable BDBAs associated

with the TPX Project that have catastrophic consequences. These events are all low probability and

low consequence. These doses are all well below the siting guideline of 25 rem (DOE 1989).

Individual BDBAs would result in less than one excess health effect in the exposed population.

4.2.3.5 Occupational Doses. There is a small probability that in some areas of the TPX facility, primarily the tritium vault, an accidental release could occur while the area was occupied by

workers, exposing them to doses in excess of those calculated for the public. Systems for tritium

monitoring and cleanup, and emergency response procedures should keep worker exposures to a minimal level. The most likely, although improbable, event having the highest consequences would be a tritium generator air ingress accident. Such a rupture could result in the release of up to 25 kCi

into the room. For such a scenario, mitigative measures would minimize the dose to any individual

worker (e.g., evacuation, use of protective equipment, implementation of emergency response procedures). The potential dose consequences of this unlikely scenario would be evaluated in a TPX

Safety Analysis Report (SAR). TPX personnel would be prevented from entering the test cell during

or immediately following a pulse, so accidental exposures to radioactive material in the test cell would

be highly improbable.

4.2.3.6 Nonradiological Impacts. Abnormal events caused by natural phenomena, accidents with external origins, transportation accidents, or operational accidents could release chemicals,

nitrogen gas, diesel fuel, hot water, etc. into the environment. Fire, explosion of boiler fuel, and

boiler overpressurization and subsequent explosion represent other potential hazards. These accidents

represent hazards associated with many industrial facilities and are not unique to the TPX facility.

Such risks are effectively managed in industry and should not cause safety concerns at TPX.

Environmental impacts would vary with the nature and severity of the accident. Potential impacts

might include temporary degradation of air or water quality, possible destruction of forested areas and

associated fauna in the event of a large fire, and injury to workers. Mitigative and other measures

would minimize the hazards and reduce the potential environmental effects of accidents. The likelihood of such an accident is small. All cryogenic substances would be handled according to established industry standards, which would limit the probability of any accident resulting in cryogen

releases to very low levels. Also, PPPL has emergency response capabilities for fire-fighting.

There is a potential for minor accidents common to light industry at the project site during construction and operation. Generally, such accidents would have no offsite effects. Roughly the

current TFTR rate of lost worker cases would be expected to occur during the lifetime of the TPX Project.

Beryllium as a design alternative might be used as a first wall armor material in TPX, and the plasma could erode some of this beryllium into dust. Beryllium is a toxic chemical hazard if inhaled

in the form of dust or aerosol. The only event that could mobilize this material and make it available

to workers would be an accident that breached the vacuum vessel when personnel were in the test cell

(TPX will not be operated when there are personnel in the test cell, however, it could be in a cleaning

bakeout mode at 350°C). A bounding amount of dust in TPX is 100 g (Cadwallader and Motloch 1993), and for a small leak combined with failure of the torus cleanup systems at 4×10^{-4} per year,

perhaps up to 33% of this dust (Deleanu 1986) could be released to the test cell. For a uniform spread of beryllium in the test cell, the concentration in air would be 33 g / 24,198 m³, or about 1.4 mg/m³. That concentration is 700 times the threshold limit value for worker exposure of 2 g/m³

(ACGIH 1991). Workers would be required to evacuate the test cell to avoid exceeding threshold limit exposure. Since tritium would be released with the beryllium, radiation monitors would alert

personnel to evacuate. Health effects in animals for short-term exposure (less than or equal to 14

days) from breathing beryllium and its compounds are available (PHS 1988). The lowest-observed-adverse-effect-level (LOAEL) for animals for a 14-day exposure is 4.3 mg/m³. At a higher level of 13

mg/m³ but for only 1 hour, rats and mice developed proliferative changes in the lung. No quantitative

data for short-term exposure were available for humans. The study warns that berylliosis may occur

in humans at exposure levels lower than the chronic animal LOAEL, and that minimal risk levels cannot be derived for inhalation exposure to beryllium and its compounds. However, health

effects

appear to be related to the duration of inhalation as well as its concentration in air. Rapid evacuation

of the area by workers prompted by radiation alarms would limit their cumulative short-term exposure

to levels considerably less than those that the animals experienced in the study, thus limiting the

potential adverse health effects.

For public exposure, the bounding amount of beryllium dust releasable would be the 100 g cited above, combined with another 100 g eroded by a severe plasma disruption. With the vacuum vessel breach to the test cell while the machine is hot and assuming failure of the torus cleanup system (overall frequency of 2×10^{-4} per year), all the beryllium is conservatively assumed to leave the

vacuum vessel and enter the test cell. If stacked through degraded HEPA filters, assumed to be only

90% efficient at the time of the accident, the amount of beryllium released to the environment would

be 20 g (Cadwallader and Motloch 1993). Over an hour release time, beryllium exposure to the maximum exposed individual would be $(20 \text{ g} / 3600 \text{ sec}) \times (4.8 \times 10^{-4} \text{ s/m}^3)$, or 2.6 g/m³. This exposure is slightly over the typical allowable worker exposure, but in accident situations of brief

duration, and low frequency, up to 3 times the threshold limit value is acceptable (ACGIH 1991). No

long term health effects are anticipated from this potential exposure.

The TPX Final Safety Analysis Report (to be published) would provide specific information regarding site characteristics, systems, components, equipment, and operational organizations to ensure

safe operation of the TPX. Potential accidents would be re-examined in the preparation of the Final

Safety Analysis Report.

4.2.4 Impacts of TPX Decontamination and Decommissioning

For D&D of a nuclear fusion facility such as the TPX facility, the radioactive inventory can be

divided into two categories: radioactivity induced by neutron activation of the machine and adjacent

structures, and radioactive contamination consisting of radioactive material deposited on the internal

and external surfaces of the machine and various associated systems. Tritium contamination of systems and on structural surfaces would be expected if TPX used tritium in its last year of operation.

High activation levels near the tokamak would also be expected. An accurate estimate of the total

radioactive inventory in the facility would be prepared prior to beginning D&D activities so that

decisions regarding the specific techniques used in D&D as well as the duration of interim storage

could be based on the amount and type of radioactivity in the facility. Estimates of the radionuclide

inventory that would remain at the TPX facility at various times following the operational schedule

would be developed using approved neutronics models and methods.

The potential environmental impacts of TPX D&D would be essentially the same as those from TFTR D&D. Safe shutdown and partial D&D of TFTR have been evaluated in section 4.1 of this EA; based on this analysis, only minor impacts would be expected to occur during TPX D&D. Potential impacts identified for TFTR D&D include minor nonradiological impacts (e.g., dust, noise, and exhaust emissions), and radiological impacts (e.g., occupational doses and waste disposal). As required by DOE Order 5820.2A (DOE 1988), the potential environmental impacts of TPX D&D would be fully evaluated as necessary in subsequent documentation.

During TPX D&D activities, all radioactive waste material, (approximately 2,500 tons) would be shipped to a designated DOE disposal site. Solid waste would consist of solidified decontamination

waste and contaminated or activated materials. All waste material would qualify as low-level waste,

and would be acceptable for shallow land disposal. Shipments of radioactive waste would meet the transportation criteria of 49 CFR 170-189, which limit the dose to the public to acceptable levels.

Although structural activation at TPX might be higher than for TFTR, this would not represent any unique D&D problems or environmental consequences. Radiation doses to D&D workers would be limited to less than 1,000 mrem per year and an increased probability of health effects of 5×10^{-4} for

an estimated 2 year period. Additionally, experience gained during TFTR D&D activities would aid TPX D&D.

4.2.5 Unavoidable Adverse Impacts

Construction of the TPX would result in some unavoidable impacts which would be minor and temporary. Construction consequences such as increased noise levels and emissions from equipment exhaust, possible increased sediment loading of surface waters during storms, and the disruption of the

visual environment would be temporary. There would also be an unavoidable potential for a few occupational injuries during construction.

Very minor air quality effects due to vehicle and boiler fuel combustion emissions would occur.

The visual environment would be slightly affected by the sight of cooling tower plumes. Small quantities of hazardous and radioactive waste requiring disposal would be generated, but the amounts

generated would not adversely affect current disposal facility capacity. There would also be releases

of radioactivity which could result in very small doses to members of the public, however no excess

health effects would result.

4.2.6 Irreversible and Irrecoverable Commitments of Resources

Construction of the proposed TPX Project would require amounts of water and electricity comparable to amounts required by other construction projects of similar scope. Heavy equipment would consume diesel fuel, and approximately 300,000 worker-hours of labor would be beneficially expended during construction, installation, and assembly work. Some building materials, such as concrete and steel, might not be fully recoverable after D&D. If precious metals, strategic and critical

materials, or resources having small natural reserves are used, they would be recovered and recycled

to the extent practical at the time.

Utility use, except for electrical power, would occur at roughly the current rate, for a period of

approximately 10 years. TPX would require more electric power during operation than does TFTR.

However, based on discussions with the utility (PSE&G 1993), this increase in pulse power consumption would not have an adverse effect on the electrical supply system for the PPPL site or surrounding area. Almost all of the tritium used in TPX D-T operation could be reclaimed. Land or

space elsewhere (possessing the appropriate State and Federal permits and licenses) would be

committed for receiving hazardous, radioactive, or nonradioactive wastes generated during operation or

D&D activities.

4.2.7 Cumulative and Long-Term Impacts

No adverse long-term environmental impacts are expected from normal operations of the TPX Project. If used during the last year of TPX operation, tritium releases would not constitute a measurable contribution to background radiation levels, because of the small amount of tritium to be

released, its relatively short half-life (12.3 years), and rapid dispersion in the environment. Direct

radiation from other PPPL devices (principally the PBX-M) are expected to contribute less than 1 mrem/yr to the D-site environs (Finley and Stencel 1992), so cumulative impacts from direct radiation

are expected to be minimal.

There are currently no measurable cumulative impacts occurring between PPPL and other

facilities in the region, and none would be expected for the proposed TPX Project. Releases of radionuclides to the atmosphere by commercial operations (such as hospitals and research laboratories)

near PPPL are not detectable in environmental samples collected around PPPL; analyses show no radionuclide concentrations above background levels (Finley and Stencel 1992). Operation of the TPX

at the PPPL would not change the existing environment near PPPL.

The calculated maximum radiological dose to an individual at the PPPL site boundary resulting from each year of TPX D-D operation at PPPL is 4.2 mrem, and the calculated dose from 1 year of TPX D-T operation at PPPL is 9.6 mrem (Table 4-2). Therefore, the maximum cumulative dose to an individual at the PPPL site boundary resulting from 10 years of TPX operation at PPPL would be 48 mrem (9 years of D-D operation would result in 38 mrem and 1 year of D-T operation would result in 10 mrem). Based on this cumulative dose and a risk factor (probability) for individual members of the public of 5×10^{-4} per person-rem (Section 4.2.2.2.4), the cumulative probability of

health effects to a member of the public from 10 years of normal TPX operations at PPPL is 2.4×10^{-5}

(2.4 chances in 100,000). The calculated population dose resulting from each year of TPX D-D operation at PPPL is 7.5 person-rem, and the calculated dose from 1 year of TPX D-T operation at PPPL is 24 person-rem. Therefore, the cumulative population dose resulting from 10 years of TPX operation at PPPL would be 91 person-rem (9 years of D-D operation would result in 67 person-rem and 1 year of D-T operation would result in 24 person-rem). Based on this cumulative population dose and a risk factor of 500 cancer deaths per million person-rem (Section 4.2.2.2.4), no resulting

fatal cancers would be expected in the population surrounding PPPL from 10 years of normal TPX operations (the calculated total number of fatal cancers is 0.05). Likewise, no cumulative individual

or collective health effects would be expected for the ORR alternative.

Radiological emissions from existing facilities at ORR were considered in assessing cumulative impacts of siting the TPX at that location. Tritium, the predominant contributor to offsite dose from

the proposed TPX effluents, typically represents about 35% of the offsite dose from airborne effluents

from the ORR (EPA 1989). During the years 1985-1989, releases of tritium to air from ORR facilities

ranged from 20,000 to 44,000 Ci per year (average of 28,800 Ci per year) (Jacobs and Wilson 1990).

The estimated airborne tritium release of 500 Ci per year from the TPX is less than 2% of this 5-year

average. Releases of tritium to surface water at ORR are less than airborne releases (Jacobs and Wilson 1990). Offsite doses from all airborne releases from ORR are well within the current EPA standard of 10 mrem per year.

Operation of existing facilities at ORR, and strip mining and other operations adjacent to ORR,

have impacted surface water and groundwater quality near ORR. The impacts of TPX would be negligible. The extensive environmental monitoring program at ORR will continue to measure cumulative impacts of ORR operations and other regional sources.

Waste products, including those from D&D activities, would require disposal, and would add to existing waste accumulation, and to the environmental impacts associated with disposal facilities. The amount of wastes generated during TPX operation would be small and would not adversely impact disposal capacity.

4.3 Combined Cumulative and Long-Term Impacts of the TFTR D&D and TPX Projects

This section addresses combined potential impacts resulting from the two connected proposed actions.

RWSB and storm water detention cell construction activities may overlap with some TFTR safe shutdown and/or D&D activities, and direct cumulative impacts are possible. The only noticeable direct cumulative impact would be a simultaneous increase in onsite traffic. These are discussed in Section 4.1.1. No TPX construction or operation activities are planned during TFTR safe shutdown or D&D activities.

Little or no cumulative or indirect impacts from releases of radioactive material are expected to occur. There have not been measurable environmental concentrations of releases from previous devices in operation at PPPL (DOE 1992), and any minor releases from TFTR D&D would occur several years before any releases from the TPX Project occurred. The levels of tritium releases from either proposed project during normal operations would be very low. Because of the low release levels, the relatively short half-life of tritium (12.3 years), and its rapid dispersion in the environment, there would be little or no measurable contribution to background radiation levels, even if tritium were used in the last year of TPX operation. No indirect or cumulative impacts with other facilities would occur (Sections 4.1.5 and 4.2.7).

Construction and occupational doses would be slightly higher than if the two projects were not connected, as proposed. TFTR D&D doses would be higher because of a shorter safe shutdown time period (to accommodate the TPX schedule), and therefore less time for radioactive decay of activated TFTR components. TPX occupational doses would be slightly higher than if the projects weren't connected because of low levels of residual TFTR radioactivity in the Test Cell from neutron activation during previous TFTR operations. Neither of these higher dose categories would exceed

DOE or PPPL requirements. A positive cumulative combined impact would be realized because of reuse of the TFTR facilities and systems and by a reduction in potential TPX construction impacts at ORR.

No incremental impacts of either project that, when added to impacts of other past or present projects, would be detrimental. No significant environmental effects have resulted from previous devices at PPPL, such as PBX-M and the Princeton Large Torus (DOE 1992). Similarly, no adverse long-term impacts would result from either proposed project, either separately or combined. Beneficial long term impacts from the connected projects include timely accomplishment of required waste management activities, beneficial reuse of a major investment in equipment and personnel at PPPL, and continued progress in fusion energy research. These projects would contribute towards development of a feasible fusion energy source that would conserve natural resources currently expended for other forms of energy production, as well as minimize environmental impacts associated with current energy sources. Finally, reusing the TFTR facility, and thereby not requiring more extensive expenditures of resources, represents a long term benefit by allowing such resources to be used elsewhere.

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5.0 COMPARISON OF PROPOSED ACTIONS AND ALTERNATIVES

This section summarizes the incremental impacts of the two projects and their alternatives evaluated in this EA as compared to existing PPPL operations. Also, impacts of combinations of the two proposed actions and their alternatives are summarized. Details of these impacts for individual projects and alternatives can be found in the corresponding sections in Section 4.

The environmental impacts of the two projects and alternatives are summarized in the following tables. The environmental impacts for both of these projects, as well as their alternatives, would generally result in no adverse impacts. In those categories where impacts would occur they would be slight and/or temporary.

Table 5-1 contains the summary comparison of the impacts expected from both the construction and operations of the proposed action and alternatives of the TFTR D&D Project. Tables 5-2 and 5-3 contain the summary comparisons of both the proposed TPX action and alternatives for construction and operations respectively. Table 5-4 presents the overall environmental impacts from the possible combinations of the proposed actions and alternatives of both the TPX and TFTR D&D Projects. More thorough discussions of impacts are provided in Section 4.

Table 5-1. Summary comparison of environmental impacts of construction and operation of TFTR D&D alternativesa.

Impact Category	Proposed Action and Delayed	
	D&D Alternative	No Action
Air Quality	Temporary increase in levels of fugitive dust and vehicle emissions during construction	No impacts

Noise	Slight, temporary increase in onsite noise during construction	No impacts
Water Quality & Quantity	Temporary increase in sediment load in Bee Brook during construction, within limits of surface water permit	No impacts
Aquatic Ecology	Temporary, reversible impacts due to sediment loading possible	No impacts
Terrestrial Ecology	Resident animals may be temporarily disturbed by increased noise associated with new construction.	No impacts
Land Use	Approximately 560 m ² (6,000 ft ²) of onsite land area would be committed to the RWSB, and approximately 1,300 m ² (14,000 ft ²) of onsite land area would be committed to a second storm water detention cell No adverse impacts on offsite disposal facilities	No impacts
Socioeconomic Environment	Temporary increase in work force during construction	Eventual loss of at least 220 jobs
Radiological Impacts from Normal Operations	Less than 1 mrem/yr to individual member of public, no adverse occupational doses	No impacts
Work Accidents	Approximately 0.2 and 5 injuries during construction and operations, respectively. No change for current operations in expected injuries/fatalities	Approximately 0.5 injuries, .001 fatality
Shipping Accidents	Very small probability of accidents	No impacts

a. Impacts are listed as incremental changes from current TFTR operations. There were no identified impacts to the visual environment or historical and archeological resources.

Table 5-2. Summary comparison of environmental impacts from construction for the proposed TPX Project and alternatives.a

Impact category	Proposed TPX	No action TPX	ORR site alternative
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Air Quality	Low levels of fugitive dust and vehicle emissions	No impacts	Slightly higher than PPPL, still acceptable
Noise	Temporary, minor increase onsite	No impacts	Temporary increase onsite
Water Quality & Quantity	Occasional, temporary and slight increase in sediment loading & siltation	No impacts	Occasional, temporary and slight increase in sediment loading & siltation
Land Use	No change in offsite land use; commitment of onsite land for new construction.	Decrease in waste disposal volume requirements	Commitment of land at ORR (more than at PPPL) for construction of TPX
Socioeconomic Environment	Small, temporary increase in PPPL employment	Eventual loss of approximately 220 jobs at PPPL	Increase of 220 jobs at ORR and loss of 220 jobs at PPPL
Work Accidents	< 1 LWCs/year of construction, 10% increase in vehicles onsite	No impacts	Slightly > 1 LWCs/year of construction, 5% increase in vehicles onsite
Radiological Impacts	Occupational doses < 200 mrem/yr for construction workers	No impacts	Occupational doses less than DOE limit

a. Impacts listed are incremental changes from current TFTR or ORR operations. No adverse impacts were identified to the terrestrial or aquatic ecology, visual environment, or historical or archeological resources.

Table 5-3. Summary comparison of environmental impacts from operations for the proposed TPX Project and alternatives.a

Impact category	Proposed TPX	No action TPX	ORR site
Air Quality	Slight increase in fuel combustion products compared to current TFTR operations	No impacts	Small increase in vehicle emissions & fuel combustion products due to new facility
Water Quality & Quantity	No impacts	No impacts	Slight increase in effluents would be negligible relative to flow rate of Poplar Creek
Land Use	Minimal land required for disposal of waste at off-site facilities	No impacts	Minimal land required for disposal of waste at offsite facilities
Socioeconomic Environment	No change in current PPPL work force	Approximate loss of 220 PPPL workers	Increase of approximately 220 new jobs and a slight increase in local population from new ORR employees
Work Accidents	Continuation of current low rate of minor accidents	No impacts	Slight increase in ORR work accidents
Radiological Impacts	No change from current operations	No impacts	Estimated 1 mrem/yr to maximum exposed individual (public); no health effects

a. Impacts are listed as incremental changes from current TFTR or ORR operations. No adverse impacts were identified in the areas of noise, terrestrial or aquatic ecology, visual environment, or historical and archeological resources.

[Table](#)

6.0 ENVIRONMENTAL REGULATIONS AND STANDARDS

The TFTR D&D and TPX Projects and their alternatives would require compliance with applicable environmental requirements. The projects would be operated under the jurisdiction of DOE, which has primary responsibility for managing environment, safety, and health (ES&H) programs at DOE-owned, contractor-operated facilities. DOE is generally subject to both the substantive and procedural requirements of the federal environmental statutes.

6.1 Federal Environmental Policies and Regulations

DOE has issued management directives (DOE orders), pursuant to the Atomic Energy Act, for its various operations. The provisions of the NEPA are implemented for DOE actions by DOE Order 5440.1E (DOE 1992a) and 10 CFR 1021 (DOE 1992b). The primary DOE order implementing general safety and environmental policies and regulations pertaining to the TFTR D&D and TPX Projects is DOE 5480.4 (DOE 1991a). The purpose of this order is to specify requirements for the application of mandatory ES&H standards applicable to all DOE and DOE contractor operations. The provisions of DOE 5480.4 must be followed during facility design, construction, operation, modification, and decommissioning. Facilities covered by this order include those owned, leased, or otherwise controlled by the DOE or leased by DOE contractors for use in work for the DOE and include facilities of either a permanent or temporary nature (e.g., trailers, rented space, and field sites). Specifically, this order is applicable in all situations where, under the contractual arrangements for the work to be performed, DOE has authority to establish and enforce environmental ES&H protection program requirements.

Since jurisdictional overlaps might occur, it is DOE policy that in instances where both DOE and non-DOE ES&H standards are applicable and mandatory, and there are conflicts between such standards, the ES&H standards providing greater protection shall govern.

In addition to DOE 5440.1E and 5480.4, other DOE orders which apply to the environmental compliance aspects of the proposed projects include:

DOE 5000.3B	Occurrence Reporting and Processing of Operations Information
DOE 5400.1	General Environmental Protection Program
DOE 5400.2A	Environmental Compliance Issue Coordination
DOE 5400.3	Hazardous and Radioactive Mixed Waste Program

DOE 5400.5 Radiation Protection of the Public and the Environment
DOE 5480.1B Environment, Safety, and Health Program for DOE Operations
DOE 5480.5 Safety of Nuclear Facilities
DOE 5480.11 Radiation Protection for Occupational Workers
DOE 5480.19 Conduct of Operations Requirements for DOE Facilities
DOE 5480.20 Personnel Selection, Qualification, Training, and Staffing
 Requirements at DOE Reactor and Non-Reactor Nuclear Facilities
DOE 5481.1B Safety Analysis and Review System
DOE 5482.1B Environment, Safety, and Health Appraisal Program
DOE 5483.1A Occupational Safety and Health Program for DOE Contractor
 Employees at Government-Owned Contractor Operation Facilities
DOE 5484.1 Environmental Protection, Safety, and Health Protection
 Information Reporting Requirements
DOE 5500.2B Emergency Categories, Classes, Notification and Reporting
 Requirements
DOE 5500.3A Planning and Preparedness for Operational Emergencies
DOE 5700.6C Quality Assurance
DOE 5820.2A Radioactive Waste Management
DOE 6430.1A General Design Criteria

DOE field offices (e.g., DOE-CH) issue orders further implementing the above orders, with occasional exceptions.

In addition to DOE orders, other statutory requirements apply. The statutes and executive orders relating to environmental quality that are potentially applicable to the proposed projects include:

Atomic Energy Act
Department of Energy Organization Act
National Environmental Policy Act
Archaeological and Historic Preservation Act
Archaeological Resources Protection Act
Clean Air Act
Clean Water Act (Federal Water Pollution Control Act)
Safe Drinking Water Act
Fish and Wildlife Coordination Act
Endangered Species Act of 1973
Comprehensive Environmental Response, Compensation, and Liability
Act (CERCLA) of 1980, as amended
Resource Conservation and Recovery Act (RCRA) of 1976 (Solid
Waste Disposal Act), as amended
Toxic Substances Control Act (TSCA)

Noise Control Act

Hazardous Materials Transportation Act

Executive orders:

- Executive Order 12088, Federal Compliance with Pollution Control Standards
- Executive Order 11514, Protection and Enhancement of Environmental Quality
- Executive Order 11991, Relating to the Protection and Enhancement of Environmental Quality
- Executive Order 11738, Providing for Administration of the Clean Air Act and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants, or Loans
- Executive Order 11807, Occupational Safety and Health Programs for Federal Employees
- Executive Order 11490, Assigning Emergency Preparedness Functions to Federal Departments and Agencies
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands

The DOE has recently issued a Regulatory Guide that provides guidance for developing a radiological effluent monitoring program at DOE sites (DOE 1991b). The guide establishes elements of a radiological effluent monitoring and environmental surveillance program considered acceptable to DOE, in support of DOE orders 5400.5 and 5400.1.

Atmospheric effluents from the proposed projects must also comply with the EPA Air quality Regulations 40 CFR 61, Subpart H, NESHAPS (National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities). A NESHAPS application for approval to construct will be developed and EPA approval obtained prior to facility construction.

PPPL has added a stack sampler to the TFTR facility for tritium releases to meet the NESHAP radionuclide emission requirement for D-T operation (Finley and Stencel, 1992). For point source discharges to waters PPPL operates under the NJPDES and ORR operates under National Pollution Discharge Elimination System (NPDES) permits. All effluents from the proposed projects would be within existing permit limits.

The operational radiological limits and guidelines for both proposed projects must address:

- (a) a limit of 10 mrem/yr EDE to any member of the public from atmospheric emissions of radionuclides other than radon (40 CFR 61, subpart H and DOE 5400.5),
- (b) a limit of 100 mrem/yr EDE for total radiological exposures to a member of the public from all pathways (DOE 5400.5),
- (c) a limit of 4 mrem/yr for EDE to any individual due to man-made radionuclides in municipal drinking water supplies (40 CFR 141 and DOE 5400.5), and
- (d) a guideline of 1 to 5

rem for accidental releases for emergency planning purposes (DOE Order 5500.3). These four limits and guidelines have the effect of bounding the potential operational releases by means of the airborne, liquid effluent, and direct radiation pathways, and of dictating the objectives of the designs of systems that will prevent or mitigate accidental releases. In addition to these limits, operations for the proposed projects will comply with DOE policy, which is to reduce radiological exposures to ALARA. The TPX radiological safety design criteria are such that the maximum projected individual (member of the public) EDE resulting from normal operations would be less than the design goal of 10 mrem/yr.

6.2 State and Local Regulations, Standards and Permits

The TFTR D&D and TPX Projects would be required to comply with several New Jersey environmental laws. These statutes cover four broad areas of facility operation: radioactive discharges, nonradioactive air pollution, nonradioactive water pollution, and noise pollution. Various sections of the state's Administrative Code (NJAC) address these areas. The NJAC also addresses nonradioactive solid wastes; however, for the PPPL site these solid wastes would be handled by municipal collectors that are already licensed and permitted. The applicability of state and local requirements would be determined by DOE, and applicable requirements would be met.

PPPL currently has several required state environmental permits for C- and D-sites. These include NJPDES permit number NJ0023922 for liquid discharges to surface waters and number NJ0086029 for discharges to the groundwater. PPPL has also submitted a permit application for the site's storm water runoff (not draining to the detention basin) and for the filter backwash discharge at the Delaware and Raritan Canal pump house (Finley and Stencel 1992). The New Jersey Department of Environmental Protection and Energy (NJDEPE) has also issued permits to PPPL for its C-site boilers and fuel tank vents for atmospheric effluents. Other permits include ones for the CAS building degreaser, the TFTR Field Coil Power Conversion (FCPC) building degreaser, the TFTR standby diesel generator engine, an 8,000 gallon unleaded gasoline tank vent (#E2), and a 15,000 gallon diesel tank vent (#E8) (Finley and Stencel, 1992). The proposed actions in this EA may require a Stream Encroachment Permit, a NJPDES Stormwater General Permit (Construction), and a Certified Soil Erosion and Sediment Control Plan. The projects would comply with all current and future NJDEPE permit requirements.

DOE would adhere to the required notification requirements of NJAC, Section 7:28-18, although these requirements are not necessarily applicable to TFTR D&D or TPX.

Section 7:28-18.2 generally puts two state reporting requirements on operators of nuclear facilities:

prior to construction, a general description of the proposed facility must be submitted to the

State,
and a program of radiological monitoring must be developed and submitted to the NJDEPE 6 months before operation is scheduled to begin.

No conflicts with local land use policies have been identified for either proposed action. As part of its Community Outreach Program, PPPL keeps local governing bodies informed of its activities; therefore, any conflicts dealing with the proposed projects at that site would be identified by local planning and/or governing bodies.

All applicable state and local statutes would be identified by DOE and incorporated into the design, construction, and operation of the proposed projects. Verification of compliance with applicable regulations will occur through operational readiness reviews conducted by DOE.

6.3 References

DOE, 1991a. "Environmental Protection, Safety, & Health Protection Standards," DOE Order 5480.4, U.S. Department of Energy, September 20, 1991.

DOE, 1991b. "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," DOE /EH-0173T, U.S. Department of Energy, January, 1991.

Finley, V. L. and J.R. Stencel, 1992. Princeton Plasma Physics Laboratory (PPPL) Annual Site Environmental Report for Calendar Year 1991, PPPL-2862, November 1992.

DOE, 1992a. "National Environmental Policy Act Compliance Program," DOE Order 5440.1E, U.S. Department of Energy, November 1992.

DOE, 1992b. National Environmental Policy Act Implementing Procedures, U.S. Department of Energy, 10 CFR 1021.

7.0 CONSULTATIONS REGARDING ENDANGERED SPECIES AND HISTORIC PRESERVATION

The following offices have been contacted via written correspondence. Copies of the responses are included in this section. Based on these and previous correspondence from these offices, no endangered species or historical resources are expected to be potentially affected by either the TFTR

D&D Project or the TPX Project.

1. Historical Preservation Office, New Jersey Department of Environmental Protection and Energy, CN-404, Trenton, NJ, 08625. Response from James F. Hall, Deputy State Historic Preservation Office to Ms. Lois M. Thompson, EH-23.
2. U.S. Fish & Wildlife Service, 927 North Main St., Building D-1, Pleasantville, NJ, 08232. Response from Clifford G. Day to Mr. Milt Johnson, DOE-PAO.
3. State of New Jersey Natural Heritage Program, Office of Natural Land Management, CN-404, Trenton, NJ, 08625. Response from Rick Dutko to Dr. Milton Johnson, DOE-PAO.
4. State of New Jersey Division of Fish, Game, and Wildlife, CN-400, Trenton, NJ, 08625-0400. Response consisted of species list (included) and miscellaneous information on endangered species.

State of New Jersey
Department of Environmental Protection and Energy
Division of Parks and Forestry
Historic Preservation Office

Scott A. Weiner
Commissioner

CN 404
Trenton. NJ 086250404
Tel.# 609-292-2023
Fax# 609-292-8115

Nancy Zerbe
Administrator

HPO-B93-176

May 3, 1993

Ms. Lois M. Thompson
Federal Preservation Officer
Office of Environmental Guidance (EH-23)
Department of Energy
100 Independence Avenue, S.W.
Washington, DC 20585

Middlesex County, New Jersey
Plainsboro Township

Tokamak Fusion Test Reactor- Decontamination &
Dismantling
Tokamak Physics Experiment- Building

Plasma Physics Laboratory
Forrestal Campus
Princeton University
United States Department of Energy

Dear Ms. Thompson:

By letter of February 10, 1993, Mr. Michael A. McKenzie-Carter of Science Applications International Corporation, Idaho Falls, has asked me for Consultation Comments pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended. As you know, the issuing of consultation comments, in accordance with the implementing regulations set forth at 36 C.F.R. 800, takes place between a state historic preservation office and the head of a federal agency, thereby assisting him to comply with the mandate of Section 106.

My staff and I have reviewed the possibility that the Tokamak Fusion Test Reactor is a technological-scientific property of such pivotal importance as to possibly constitute an exception to the half-century threshold for National Register of Historic Places eligibility. As one of three large Tokamak reactors in the world, and the only large one in the United States, the Princeton Tokamak Fusion Test Reactor warranted consideration of National Register eligibility. However, in consultation with the National Register office in Washington, we have evaluated it as not meeting the exception rule and therefore not being eligible for the National Register of Historic Places.

Construction on the Princeton Tokamak began in the mid-1970's and the machine was first operated in 1982. Due to its extremely young age, it would need to have made a major impact on American history in order to be considered an exception to the 50 year threshold for National Register eligibility. As scientific breakeven has not been reached, it is our opinion that it has not been demonstrated that events associated with the Tokamak have had a significant impact on American history.

Therefore, it is my opinion as Deputy State Historic Preservation Officer that the proposed undertaking will not affect any resource on or eligible for the National Register of Historic Places.

Sincerely,

James F. Hall
Deputy State Historic
Preservation Officer

JFH:vp

C. Dr. George T. Mazuzan, N.S.F.
Mr. Milton Johnson, D.O.E., Princeton
Dr. Michael A. McKenzie-Carter, Idaho Falls
Dr. Benjamin F. Cooling, D.O.E., Chief Historian
Dr. Paul Forman, National Museum of American History
Advisory Council on Historic Preservation

Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville. New Jersey 08232

Tel: 609-646-9310

FAX: 609-646-0352

March 5, 1993

Mr. Milt Johnson
Manager, Princeton Area Office
U.S. Department of Energy
P.O. Box 102
Princeton, New Jersey 08544

Dear Mr. Johnson:

This responds to the February 10, 1993. request to the U.S. Fish and Wildlife Service (Service) from Science Applications International Corporation, on your behalf, for information on the presence of federally-listed endangered and threatened species in the vicinity of two proposed Department of Energy sponsored projects at Princeton University, Forrestal Campus, Plainsboro Township, Middlesex County, New Jersey. The projects are the Tokamak Fusion Test Reactor Decontamination and Decommissioning and the Tokamak Physics Experiment.

Authority

This response is provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate

review and comments by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 et seq.), if any permits are required from the U.S. Army Corps of Engineers pursuant to the Clean Water Act of 1977 (33 U.S.C. 1344 et seq.), nor do they preclude comments on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 et seq.).

Listed and Candidate Species

Enclosed are current summaries of the federally-listed and candidate species in New Jersey for your information. Except for an occasional transient bald eagle (*Haliaeetus leucocephalus*) or peregrine falcon (*Falco peregrinus*), no federally-listed or proposed threatened or endangered flora or fauna are known to occur within the vicinity of the project area.

Candidate species are species under consideration by the Service for possible inclusion on the List of Endangered and Threatened Wildlife and Plants. Although candidate species receive no substantive or procedural protection under the Endangered Species Act, the Service encourages federal agencies and other planners to consider candidate species in the project planning process. The State Natural Heritage Program provides the most up-to-date data source for candidate species in New Jersey, as well as maintaining information on State listed species, and may be contacted at the following address:

Mr. Thomas Breden
Natural Heritage Program
Division of Parks and Forestry
CN 404
Trenton, New Jersey 08625
(609/984-0097)

Should the Natural Heritage Program data search reveal the presence of any candidate species within the project area, the Service must be contacted to ensure that these species are not adversely affected by project activities.

Further information on State listed wildlife species may be obtained from the following office:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609/292-9400)

Wetlands

The Service's National Wetland Inventory map (Hightstown, New Jersey quadrangle) indicates that palustrine wetlands occur within the project study area. Wetlands provide habitat for a variety of migratory and resident species of fish and wildlife. Thus, the Service discourages activities in and affecting the Nation's wetlands that would unnecessarily damage, degrade, or destroy their values. Project activities in wetlands may require federal and State permits from the U.S. Army Corps of Engineers pursuant to the Clean Water Act, and the New Jersey Department of Environmental Protection and Energy (NJDEPE) pursuant to the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.). Thus, if work is proposed in wetlands, the following offices must be contacted to determine federal and State permit requirements, respectively:

Regulatory Branch
U.S. Army Corps of Engineers
New York District
26 Federal Plaza
New York, New York 10278-0090
(212/264-0184)

Land Use Regulation Program
Department of Environmental Protection and Energy
CN 401
Trenton, New Jersey 08625-0401
(609/984-0853)

Information contained in this letter and additional information obtained from

the aforementioned sources represents the public interest for fish and wildlife resources and should warrant full consideration in the project planning process. The Service requests that no part of this letter be taken out of context and if reproduced, the letter should appear in its entirety.

Please contact Annette Scherer of my staff if you have any questions or require further assistance regarding threatened or endangered species.

Sincerely

Clifford C. Day
Supervisor

Enclosures

State of New Jersey
Department of Environmental Protection and Energy
Division of Parks and Forestry
Office of Natural Lands Management
CN 404 Trenton New Jersey 08625-0404

Scott A. Weiner
Commissioner

(609) 984-1339
FAX (609) 984-1427

Thomas F. Hampton
Administrator

May 21. 1993

Dr. Milton Johnson
U.S. Department of Energy
P.O. Box 102
Princeton, NJ 08542

Re:The Tokamak Fusion Test Reactor Decontamination and Decommissioning
and the Tokamak Physics Experiment

Dear Mr. Johnson:

Thank you for your data request regarding rare species information for the
above referenced project site in Plainsboro Township, Middlesex County.

The Natural Heritage Data Base does not have any records for rare plants,
animals or natural communities on the site. The attached list of rare species
is from records in the general vicinity of the project site (within approx. 3
mi. for animals, 1.5 mi. for plants and communities). Additionally, enclosed
is a list of rare vertebrates of Middlesex County together with a description
of their habitats. If suitable habitat is present at the project site, these
species would have potential to be present. If you have questions concerning
the wildlife records or wildlife species mentioned in this response, we recommend
you contact the Division of Fish, Game and Wildlife; Endangered and Nongame
Species Program.

PLEASE SEE THE ATTACHED CAUTIONS AND RESTRICTIONS ON NHP DATA.

Thank you for consulting the Natural Heritage Program. The attached invoice
details the payment due for processing this data request and has been forwarded
to Science Applications International Corporation. Feel free to contact us again
regarding any future data requests.

Sincerely,

Rick Dutko
Senior Nongame Zoologist
Natural Heritage Program

cc: Michael A. McKenzie-Carter
Larry Niles
Thomas Hampton
NHP File No. 93-4007435

Species List from the State of New Jersey Division of Fish, Game, and Wildlife

Species List

Plainsboro Township

Pipit, water	<i>Anthus spinoletta</i>
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Species List

South Brunswick Township

Pickerel, redfin	<i>Esox americanus</i>
Pickerel, chain	<i>Esox niger</i>
Shiner, golden	<i>Notemigonus crysoleucas</i>
Sucker, white	<i>Catostomus commersoni</i>
Chubsucker, creek	<i>Erimyzon oblongus</i>
Bullhead, brown	<i>Ictalurus nebulosus</i>
Eel, American	<i>Anguilla rostrata</i>
Sunfish, mud	<i>Acantharchus pomotis</i>
Sunfish, redbreast	<i>Lepomis auritus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Darter, tessellated	<i>Etheostoma olmestedi</i>
Turtle, wood	<i>Clemmys insculpta</i>
Nuthatch, red-breasted	<i>Sitta canadensis</i>
Warbler, palm	<i>Dendroica palmarum</i>
Sparrow, grasshopper	<i>Ammodramus savannarum</i>

Species List

Millstone River Basin

Salamander, longtail	<i>Eurycea longicauda</i>
Turtle, common snapping	<i>Chelydra serpentina</i>
Turtle, wood	<i>Clemmys insculpta</i>
Bittern, American	<i>Botaurus lentiginosus</i>
Hawk, Cooper's	<i>Accipiter cooperii</i>
Grouse, ruffed	<i>Bonasa umbellus</i>

Bobwhite, northern	Colinus virginianus
Turkey, wild	Meleagris gallopavo
Sandpiper, upland	Batramia longicauda
Owl, barred	Strix varia
Owl, short-eared	Asio flammeus
Woodpecker, red-headed	Melanerpes erythrocephalus
Bobolink	Dolichonyx oryzivorus
Meadowlark, eastern	Sturnella magna
Sparrow, Savannah	Passerculus sandwichensis
Sparrow, grasshopper	Ammodramus savannarum
Sparrow, Henslow's	Ammodramus henslowii
Sparrow, vesper	Poocetes gramineus
Otter, river	Lutra canadensis

APPENDIX A

AIR ACTIVATION PRODUCTS PRODUCED AND RELEASED DURING TPX OPERATION

The purpose of this Appendix is to describe and document the assumptions, methodology, and calculations for estimation of production and release of air activation products during operation of the TPX at the PPPL.

A.1 Introduction

Both DD and DT operations were evaluated. The methodologies used for each mode of operation were different, as described below, and a bounding consequence for each mode was calculated. A simplified, conservative approach was taken, one that should produce consequences (releases and doses) that are higher than what would actually be produced by TPX operation. The best available information was used, and for some parameters this meant using values calculated for TFTR DT operations. Some of these values will change over the design phase of the TPX project, but the current calculations were performed with the goal of bounding eventual consequences of TPX operation.

A.2 Methodology

Both the DD and DT modes of TPX operation were evaluated. Different methodologies were used for each mode because of the information available on which to base the calculations. Calculated releases and doses from DT operations were higher than those for DD operations, therefore consequences of DT operations were carried forward to the EA.

Many assumptions and sources of information were used in order to accomplish these calculations. Assumptions that are common to both the DD and DT methodologies are listed below:

- Isotope production rates for TFTR D-T operation were used. TPX design efforts are ongoing, and calculations for TPX air activation have not been accomplished because they are very sensitive to machine and component geometry. The values used (Liew 1992) are very conservative for TPX. The actual values for TPX should be much lower, on a per neutron basis, because of a planned shield around the TPX vacuum vessel.
- Neutron production rates from the TPX General Requirements Document (GRD) were used. This is the most complete verified source of this type of information available.
- No radioactive decay during a TPX pulse was included. Isotope production per pulse was based only on the production rates and length of pulse. This was a conservative assumption made to simplify the calculations.
- Release from the Test Cell was calculated using the same methodology as in the TFTR DT EA. This methodology conforms to the current and future dimensions and operation of the Test Cell HVAC system.
- Estimation of annual release was based on release per pulse and number of pulses per year. The annual release of each radionuclide was calculated.
- CAP88-PC and AIRDOS-EPA were used for the dose calculations. New CAP88-PC runs were made for N-13 and Ar-41. The radionuclides N-16, Cl-40, and S-37 are not available in CAP88-PC, so the AIRDOS-EPA dose-to-release ratios (mrem per Ci released) from the TFTR DT EA were used for these radionuclides. The dose-to-release ratios used are shown below:

Table A-1. Dose-to-Release Ratios Used in the Calculations

Isotope	Dose-to-release ratios (mrem/Ci)	
	CAP88-PC	AIRDOS-EPA
N-13	3.10 E-03	
Ar-41	3.70 E-03	

N-16	6.97 E-05
Cl-40	8.16 E-03
S-37	1.08 E-02

The details of the dose calculations are given in DOE (1992) and McKenzie-Carter and Anderson (1993). More details of the methodologies for DD and DT modes of operation are given in the following two sections.

A.2.1 Methodology for DD Operations

In addition to the common assumptions listed in Section A.2, these additional assumptions were made for evaluation of TPX DD operations:

- In addition to the DD neutrons produced during DD pulses, DT neutrons would also be produced, at a rate of 2% of the DD neutrons.
- The neutron production rates used for DD operation are 3.0 E+16 DD neutrons per sec, and 6.0 E+14 DT neutrons per sec).
- A DD pulse length of 1000 seconds.
- A maximum production of 6.0 E+21 DD neutrons per year.
- 2.0 E+5 sec of DD operations per year.

Table A-2 shows the isotope production rates, releases, and doses calculated for TPX DD operations. An example of the methodology is illustrated below for Ar-41.

Example calculation for Ar-41:

1. The "1 second activity" values for TFTR DT operation (in units of Bq/neutron) were multiplied by the neutrons/sec and the DD pulse length to obtain a "1 pulse activity":

1 pulse activity (Bq) =

(DD 1 sec activity X DD neutrons/s + DT 1 sec activity X DT neutrons/s) X 1000 s

$$= (8.6 \text{ E-10} \times 3.0 \text{ E+16} + 8.8 \text{ E-10} \times 6.0 \text{ E+14}) \times 1000 = 2.63 \text{ E+10 Bq}$$

2. The activity released per pulse was calculated using the methodology in the TFTR DT EA:

$$\text{Release} = A \times [-d / (-r + -d)] \times e^{-rT}$$

Where A = radionuclide activity in the test cell following a pulse of 1000 sec (Bq);
 -d = dilution rate constant (test cell vent rate/test cell volume)
 = (4500 cfm / 953,500 ft³) 1 min/60 sec = 7.9 E-5 sec⁻¹;
 -r = radioactive decay constant (sec⁻¹);
 T = transit time from the test cell to the exhaust point (3 sec).

Ar-41 Release

$$\begin{aligned} \text{per pulse} &= 2.63 \text{ E}+10 \times [7.9 \text{ E}^{-5} \text{ sec}^{-1} / (1.05 \text{ E}^{-4} \text{ sec}^{-1} + 7.9 \text{ E}^{-5} \text{ sec}^{-1})] \times \text{E}^{-(1.05\text{E}^{-4} \times 3)} \\ &= 1.13 \text{ E}+10 \text{ Bq} \end{aligned}$$

3. The annual activity released was calculated by multiplying the release per pulse by the number

of DD pulses per year. The number of DD pulses per year was calculated by dividing the allowed operation time from the TPX GRD (2.00 E+5 sec/yr) by the assumed pulse length (1000 sec); this yielded 200 pulses per year.

Ar-41 Release

$$\text{per year} = 1.13 \text{ E}+10 \text{ Bq/pulse} \times 200 \text{ pulses/year} = 2.25 \text{ E}+12 \text{ Bq/year}$$

4. The release per year in Bq was converted to curies, and multiplied by the dose-to-release factors listed in Table 1, to arrive at an annual dose:

Annual dose =

$$(2.25 \text{ E}+12 \text{ Bq/yr}) \times (1 \text{ Ci}/3.7 \text{ E}+10 \text{ Bq}) \times (3.70 \text{ E}^{-03} \text{ mrem/Ci}) = 0.225 \text{ mrem/yr}$$

Releases and doses for all other radionuclides were calculated in the same manner.

Radiological decay during a TPX pulse was not included, in order to simplify the calculations. Therefore, bounding estimates of air activities for steady-state D-D operation (including 200,000 second pulse operation) can be made by multiplying the 1-sec Activity values in Table A-2 by the neutrons/sec and number of seconds of operation (maximum of 200,000 seconds/year). Thus, for a 200,000 second pulse, the maximum Ar-41 activity produced would be:

$$\begin{aligned} (8.6 \text{ E}^{-10} \text{ Bq/n} \times 3.0 \text{ E} + 16 \text{ n/sec} + 8.8 \text{ E}^{-10} \text{ Bq/n} \times 6.0 \text{ E} + 14 \text{ n/sec}) \times 200,000 \text{ sec} \\ = 5.3 \text{ E} + 12 \text{ Bq} \end{aligned}$$

A.2.2 Methodology for DT Operations

In addition to the assumptions listed in section A.2, these additional assumptions were made for evaluation of TPX DT operations:

- Pulses during DT operations were assumed to be 1000 sec in length, consisting of 998 sec of DD followed immediately by 2 sec of DT;
- The neutron production rates used for the DD portion of the pulse were $6.4 \text{ E}+16$ DD neutrons/sec and $1.3 \text{ E}+15$ DT neutrons/sec; for the DT portion, $1.6 \text{ E}+16$ DD neutrons/sec and $5.3 \text{ E}+18$ DT neutrons/sec were used (Reiersen 1993).

These two assumptions resulted in the following calculated values:

DD neutrons/pulse = $6.39 \text{ E}+19$

DT neutrons/pulse = $1.19 \text{ E}+19$

- A dose "limit" from the TFTR DT EA was used to calculate the maximum "allowed" neutron production. This was an iterative process to arrive at the adopted dose limit. The basis for this approach of using the consequences of TFTR DT operations to restrict the consequences of TPX DT operation is the TPX Project decision (Schmidt 1993) that TFTR DT EA consequences be used as limits for operation of the TPX machine. This approach requires that H-3 releases from TPX would not exceed those assumed for TFTR DT operations (500 Ci/yr), and also that direct radiation dose from TPX operation would not exceed 5 mrem/yr .

The dose limit derived from the TFTR DT EA is 3.02 mrem/yr , which was the calculated dose resulting from release of air activation products during TFTR DT operations (Table 4-1, TFTR DT EA).

A per pulse approach was used for the DT calculations also; a DT pulse was defined as consisting of 1000 sec total (W. Reiersen personal communication) - 998 seconds of DD followed immediately by 2 seconds of DT. Thus, air activation product generation and release per DT pulse were calculated, followed by calculation of annual releases and doses in the same manner as for DD operation.

The number of DT pulses per year that would result in an annual dose of 3.02 mrem from air activation products was determined iteratively, using the method and assumptions listed above. This approach resulted in the calculation of the following values:

Number of DT pulses = 795 pulses per year
DT neutrons per year = 9.5 E+21
Operating time = 1,590 seconds of DT operations/year

The values calculated above are not intended to be used as operational limits for TPX, but represent the bounds of the assumptions for these calculations. Different values for these parameters

could be used in actual TPX operation without exceeding the consequences calculated here. Some of

the parameter values may in fact be larger than the design parameter values for TPX operation.

Table A-3 shows the isotope production rates, releases, and doses calculated for TPX DT operations. The methodology for calculation of production and release is the same as for DD operations (section A.2.1).

[Table](#)

[Table](#)

A.3 REFERENCES

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APPENDIX B

TPX OPERATIONAL OCCURRENCES: RELEASE SCENARIOS FOR

TRITIUM

B.1 Introduction

Potential Off-Normal Events and Releases for the TPX (Cadwallader and Motloch 1993) discusses the background for and details of accidental tritium release events postulated for the proposed TPX Project. This appendix summarizes information contained in the assessment, including the specific tritium release scenarios for TPX, and event trees for each scenario. Projected dose consequences from the most significant of these events are given in Table 4-5 of the EA text. The locations of the components discussed in the event trees and their relationships to each other can be found in Figures B-1 and B-2. The bases for the estimated probabilities for abnormal events and accidents are addressed in Section 4.2.3 of the EA text and in Cadwallader and Motloch (1993).

As was done in Holland and Lyon (1989), a decontamination factor of 1000 was conservatively assumed for TPX tritium cleanup systems; in fact, such cleanup systems have been shown to have decontamination factors of up to 106 (Longhurst 1989). The calculated individual doses from tritium release scenarios assume (consistent with DOE, 1992) that during release and subsequent dispersion, approximately one percent of elemental tritium released is oxidized to tritiated water; the collective effective dose equivalent calculations assume that all of the released elemental tritium undergoes environmental oxidation to tritiated water.

B.2 Performance of HVAC Systems During Abnormal Events/Accidents

The heating, ventilation and air conditioning (HVAC) systems servicing the areas (test cell, test cell basement, tritium vault, gas holding tank room) where release scenarios have been postulated are indicated on the simplified flowsheet in Figure B-1. Supply air from the facility intake shaft (located east of the TPX Test Cell Complex) is brought to each of these areas by fans AC-xxx (e.g., AC-101 for test cell, AC-106 for test cell basement, etc). Return fans RF-xxx vent these areas to the facility exhaust stack (1). At the top of the stack, above where the individual exhaust ducts from each RF fan terminate, two booster fans enhance the vertical discharge air velocity from the HVAC systems (Figure B-2). Operation of one booster fan provides sufficient discharge flow for the desired velocity enhancement (note: the NOAA tracer gas tests were performed with one booster fan operating). Upon signals from one or more tritium monitors associated with the tritium area, supply and exhaust fans serving the affected room would be isolated from the room because the associated tritium seal dampers (e.g., XV-513A and XV-513C for the tritium vault) would close (within seconds) and

inflate

their seals, thereby isolating the affected room from the environment. The booster fans would continue to operate to serve unaffected areas.

Figure B-1. TFTR HVAC Systems

Electrical power is available from the TPX standby diesel generator to operate the HVAC systems in the event normal utility power is lost. A complete loss of all normal and standby electrical power would shut down all fans (including the booster fans) and close and seal all tritium seal dampers, thereby isolating all affected TPX areas from the environment. The seal dampers would function (close and seal) under design basis earthquake conditions ["most probable earthquake" and "most intense earthquake;"(DOE 1992)], as would the capability of TPX systems to contain tritium.

The two stack booster fans are separate units powered from a common motor control center. Inoperability of both booster fans during a tritium release event where room isolation has failed could be caused by: mechanical failure of both fans, electrical fault upstream of the motor control center (e.g., transformer failure, circuit breaker closure, etc.), loss of all normal and standby electrical power during the event (assumes that the appropriate seal dampers failed to function due to separate mechanical reasons), and loss of fans due to performance of maintenance. Based on the failure rate data in Cadwallader, 1988, the probability that the booster fans would be unavailable during a tritium release event is dominated by loss due to routine maintenance; the associated frequency of occurrence during the event is 5×10^{-4} (Levine 1991a). The estimated probabilities of the tritium release events in Table 4-4 (which assume stack booster fan operating in conjunction with loss of room isolation capability) are $X \times 10^{-4}$ per year; therefore, the probability of any of these events occurring at the same time that no booster fans are operating would be $< 1 \times 10^{-6}$ per year (i.e., beyond design basis).

1 The test cell and test cell basement are each providing with two dedicated redundant exhaust fans (i.e.,

RF-113/114 and RF-109/110) to maintain negative pressure in these areas. The main exhaust fans for the

tritium vault and gas holding tank room (RF-111/112). which are also redundant, operate at higher flow rates

then supply fan AC-104 to maintain negative pressure.

B.3 Discussion of Event Trees

The first event tree (Figure B-3) postulates leakage of tritium from the transfer lines within the tritium area, or from the lines that lead from the tritium area through the test cell basement to the test cell. Double-walled pipe provides a passive containment and this, combined with cleanup capability provided for the interwall space, gives a relatively low probability of failure. However, because of its relatively small size and resulting potential for structural damage, a slightly higher value of 10^{-2} is used for failure of the integrity of the outer wall. In the tritium area, any releases from the transfer lines to a room would normally be detected and isolated by the area ventilation system. If this did not occur, a release of 8 kCi of elemental tritium could occur, with a sequence probability of 10^{-6} per year. The maximum individual offsite dose would be 0.45 mrem. The maximum population dose would be about 550 person-rems. The health effects resulting from this population dose to the most populated sector would be about 0.2% of the health effects from the annual background effective dose equivalent (exclusive of radon) of 280,000 person-rem.

The second event tree (Figure B-4) addresses leaks from the gas holding tanks (GHTs) and associated piping and fittings. There are two GHTs located in the holding tank room in the TFTR basement tritium supply, cleanup and waste handling area. This area can be detritiated by the Tritium Vault Cleanup System (TVCS). The tanks are maintained at subatmospheric pressure. It is assumed for this event that a failure of a connected pipe or fitting could result in leakage. If a leak should occur, the torus cleanup system (TCS) would be used to process the contents of the affected tank, thereby preventing leakage to the room and cleaning up the tritium. If this did not occur, the holding tank room ventilation system would be isolated and the room would be cleaned up by the TVCS. If this failed to occur, the potential release could be 18 kCi of elemental tritium, with sequence probability of 10^{-5} per year. The maximum individual offsite dose would be 1 mrem and the population dose would be about 1,230 person-rems. The health effects resulting from this population dose to the most populated sector would be about 0.4% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure.

The third event tree (Figure B-5) postulates a GHT leak after helium-oxygen glow discharge cleaning. The tritium cycle through TPX, including the GHTs, is currently expected to be conducted twice per week for 40 weeks per year during the D-T Program, for a total of 80 cycles per year. Of this amount, it is anticipated that one cycle would involve a helium-oxygen glow discharge

cleaning

(He-O GDC) to pump out removable tritium from the torus vacuum vessel. This particular cycle could result in up to 20 kCi of tritiated water vapor in a GHT. The fraction of TPX cycles for which

He-O GDC would be conducted is therefore 1/80 or 1.3×10^{-2} . The probability of a stack release of

the entire contents of a leaking GHT during all tritium cycles (generally involving neutral beam cryopanel regeneration) is 1×10^{-6} per year. The maximum individual offsite dose would be 112 mrem and the population dose would be about 1,370 person-rems. The health effects resulting from this population dose to the most populated sector would be 0.5% of the health effects from the annual

280,000 person-rem background exposure (exclusive of radon).

[Figure](#)

[Figure](#)

[Figure](#)

The fourth event tree (Figure B-6) postulates a small leak in the torus vacuum boundary. Releases from the torus would be mitigated by maintaining a negative pressure in the torus with respect to the test cell with the Torus Cleanup System (TCS) for leak rates up to 50 cubic feet per minute (CFM), or with the TVCS for leak rate > 50 CFM. the most probable source for such a leak that would admit air to the torus would be from external penetrations of the vacuum boundary. Because of reactions with oxygen or water vapor, most of the release would be in the oxide form. If all mitigation fails, the result could be a release of up to 20 kCi of tritiated water from the torus at a probability of 4×10^{-4} per year. The maximum individual offsite dose would be 112 mrem and the population dose would be about 1,370 person-rems. The health effects resulting from this population dose to the most populated sector would be 0.5% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure.

The fifth event tree (Figure B-7) involves a leak from one neutral beamline. As in the torus small leak scenario, the TCS or TVCS would prevent releases to the test cell, If mitigation were unsuccessful, a release of up to 18 kCi of elemental tritium could occur with a probability of 4×10^{-4} per year. The maximum individual offsite dose would be 1 mrem and the population dose would be about 1,230 person-rems. The health effects resulting from this population dose to the most populated sector would be 0.4% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure.

[Figure](#)

[Figure](#)

[Figure](#)

The sixth event tree (Figure B-8) involves loss of the contents of one shipping container after it is loaded into the tritium receiving glovebox. After loading into the glovebox, the cover would be removed from the secondary container and the primary container would be connected to the tritium system. A procedural error could cause the contents of the container to be released to the glovebox. If the glovebox developed a major leak, the contents would be released to the tritium vault, and if vault isolation failed, a release of 25 kCi of elemental tritium could occur. The sequence probability is 10^{-5} per year. The probability for release into the glovebox of about 0.1 per year is dominated by human error. The maximum individual offsite dose would be 1.4 mrem, and the population dose would be about 1,710 person-rem. The health effects resulting from this population dose would be 0.6% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure. Since operations with the tritium containers which could lead to a loss of contents would only occur when the container is inside a glovebox, direct release outside the glovebox is considered to be beyond design basis. The likelihood and consequences of a leak in a shipping container being prepared for offsite shipment would be comparable to those described herein.

The seventh event tree (Figure B-9) postulates air ingress onto a tritium generator storage bed due to a breach of the connecting double-walled pipe outside the argon atmosphere glovebox and the resulting reactions of oxygen and nitrogen with the pyrophoric uranium. These reactions are assumed to result in a large increase in the bed temperature, and release of all the tritium on the tritiated water through the breached pipe to the vault(2). If the vault ventilation system isolates, there would be no significant release. If isolation fails to occur, the result could be a release of 25 kCi of oxidized tritium through the stack. The probability of this sequence is 10^{-5} per year. The maximum individual dose would be 140 mrem, and the population dose would be about 1,710 person-rem. The health effects resulting from this population dose would be 0.6% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure.

The eighth event tree (Figure B-10) addresses a vacuum leak in the injection line of the tritium pellet injector (TPI). As discussed above for the torus small leak and neutral beamline leak

events, the TCS and TVCS would process the leak via the vacuum pumping system and prevent releases to the test cell. If this mitigation does not take place, a release of up to 1 kCi of elemental

tritium could occur through the stack with a probability of 5×10^{-4} per year. The maximum individual dose would be 0.06 mrem and the population dose would be about 70 person-rem. The health effects resulting from this population dose would be 0.03% of the health effects from the annual 280,000 person-rem (exclusive of radon) exposure.

2 A series of experiments has recently been conducted at Ontario Hydro Research Division, Toronto,

Canada, to investigate the response of uranium storage beds for tritium to ingress of air. Analysis of the

test data from these experiments indicate that an air ingress accident involving a TFTR storage bed at

either ambient or operating temperatures would result in only a modest (non-damaging) temperature increase

of the beds and no tritium release (Longhurst 1990; Sissingh 1991).

[Figure](#)

[Figure](#)

The ninth event tree (Figure B-11) examines potential leaks from one or more gas treatment system (GTS) components which would be located inside a tritium purification system (TPS) glove box. The presence of high tritium concentrations in the glove box would automatically trigger processing of the glove box by the existing Tritium Storage and Delivery Cleanup System (TSDCS). If the TSDCS failed and the glove box were to be breached (as a result, for example, of weld failures

or leaks in penetration seals or glove ports), tritium would be released to the Waste Handling Area.

The Waste Handling Area/Tritium Cleanup Room ventilation would be automatically isolated and the area would be cleaned up by the existing Tritium Vault Cleanup System (TVCS). If ventilation is isolated but the TVCS fails to process the area atmosphere, a potential ground level release of up to

2 kCi (due to slow leakage from the area) of elemental tritium could occur, with a sequence probability of 1.5×10^{-7} per year (beyond design basis). The maximum individual offsite effective

dose equivalent (at the site boundary) from such a release would be about 0.3 mrem(3). The maximum

collective effective dose equivalent would be approximately 140 person-rem for a release to the

most

populated sector (northeast), which is approximately 0.05% of the background collective effective dose equivalent (exclusive of radon) of 280,000 person-rem received annually by the potentially exposed population. The health effects resulting from this collective effective dose equivalent would

also be about 0.05% of the health effects resulting from the background collective effective dose equivalent. If isolation of area ventilation did not occur, the release of up to 2 kCi of tritium would

be through the facility exhaust stack with a sequence probability of 1.5×10^{-7} per year (beyond design basis), and a maximum individual offsite effective dose equivalent of 0.1 mrem. The collective effective dose equivalent and potential health effects would be the same as described above

for the ground level release.

The tenth event tree (Figure B-12) examines potential leakage of tritium from a cryogenic distillation (CD) column to the cold box. In this case, the cold box atmosphere would be purged to a

3 Assumes (as in the TFTR D-T EA, DOE, 1992) that during the event and subsequent dispersion, approximately one percent of the elemental tritium was oxidized to tritiated water; the collective

effective dose equivalent calculations assume environmental oxidation of the released elemental tritium

to tritiated water.

[Figure](#)

[Figure](#)

Gas Holding Tank for processing by the existing Torus Cleanup System (TCS). If the cold box integrity fails, tritium would be released to the Waste Handling Area, ventilation of this room would

be automatically isolated, and the area would be cleaned up by the TVCS. If ventilation is isolated

but the TVCS fails to process the area atmosphere, a potential ground level release of up to 7 kCi

(due to slow leakage from the area) of elemental tritium could occur, with a sequence probability of

4×10^{-8} per year (beyond design basis). The maximum individual offsite effective dose equivalent

(at the site boundary) from such a release would be about 1.1 mrem. The maximum collective effective dose equivalent would be approximately 480 person-rem for a release to the most populated

sector (northeast), which is approximately 0.2% of the background collective effective dose equivalent

(exclusive of radon) of 280,000 person-rem received annually by the potentially exposed population.

The health effects resulting from this collective effective dose equivalent would also be about 0.2% of

the health effects resulting from the background collective effective dose equivalent. If isolation of

area ventilation did not occur, the release of up to 7 kCi of elemental tritium would be through the

facility exhaust stack with a sequence probability of 4×10^{-8} per year (beyond design basis), and a

maximum individual offsite effective dose equivalent of 0.4 mrem. The collective effective dose equivalent and potential health effects would be the same as described above for the ground level release.

In the eleventh event tree (Figure B-13), a breach in the line between the gas holding tank and

the GTS glove box is postulated to occur outside the glove box. It is assumed that sufficient oxygen

is admitted to a uranium bed to cause a reaction with the uranium tritide of the bed which releases all

the tritium on the bed (2 kCi maximum) through the breach into the Waste Handling Area as tritiated

water (HTO)(4). The Waste Handling Area/Tritium Cleanup Room ventilation would be automatically isolated and the area would be cleaned up by the TVCS. If ventilation is isolated, but the TVCS fails

to process the area atmosphere, a potential ground level release of 2 kCi (due to slow leakage from

the area) of tritiated water vapor (HTO) could occur, with a sequence probability of 1.0×10^{-6} per

year. The maximum individual offsite effective dose equivalent (at the site boundary) from such a

release would be about 31 mrem. The maximum collective effective dose equivalent would be

approximately 140 person-rem for a release to the most populated sector (northeast), which is

4 A series of experiments has recently been conducted at Ontario Hydro Research Division, Toronto,

Canada, to investigate the response of uranium storage beds for tritium to ingress of air. Analyses of

the test data from these experiments indicate that an air ingress accident involving a TFTR storage bed

at either ambient or operating temperatures would result in only a modest (non-damaging) temperature

increase of the beds and no tritium release (Longhurst 1991; Sissingh 1991).

Figure

approximately 0.05% of the background collective effective dose equivalent (exclusive of radon) of

280,000 person-rem received annually by the potentially exposed population. The health effects resulting from this collective effective dose equivalent would also be about 0.05% of the health

effects

resulting from the background collective effective dose equivalent. If isolation of area ventilation did

not occur, the release of up to 2 kCi of tritiated water would be through the facility exhaust stack

with a sequence probability of 1×10^{-6} per year, and a maximum individual offsite effective dose

equivalent of about 11 mrem. The collective effective dose equivalent and potential health effects

would be the same as described above for the ground level release.

Another event, without an event tree, is a large vacuum breach in the TPX vacuum vessel. Marchlik (1992) defined leak sizes as small (0.037 m²), large (between 0.037 m² and 0.74 m²), and catastrophic (any break area larger than 0.74 m²). The small and large breaks can be cleaned up by

the TCS and TVCS, respectively. A catastrophic breach failure frequency was estimated to be on the

order of 10^{-6} /year, an incredible event (Marchlik 1992), because the event would have to be a wall

failure since no port is large enough to result in such a large opening. There is no mitigative system

for the catastrophic breach. If this event did occur, there would be a release of the co-deposited

tritium in the torus to the cryostat and then the Test Cell. The cryostat may be able to serve as a

confinement barrier in this case, perhaps with a 10^{-1} chance of failure. The amount of co-deposited

tritium on the torus wall and armor that could escape to the room is limited, as tritium will be removed when the inventory reaches the administrative limit of 20 kCi. As in the case of the small

leak, the catastrophic break also has the potential for graphite-air reactions if the graphite tiles are

hot. Analysis has shown that the endothermic graphite-air reactions terminate and little volatilization

is expected (Cadwallader and Motloch 1993). Because of the limited time that the tiles are hot (approximately 500 hours/year), the probability of a graphite-air reaction would be about an order of

magnitude less than the base scenario of 10^{-7} /year, and the maximum tritium source term would be 20 kCi.

The large break in the torus (failure of one of the largest ports) was estimated to occur with a

frequency of about 10^{-3} /year (Marchlik 1992). In this event, the cryostat is bypassed by air streaming

into the vacuum vessel through the breached port. Results are the same as for the catastrophic leak

case, with the maximum tritium inventory of 20 kCi being released. The TVCS would be called on, with a 10^{-2} /demand failure rate, giving a sequence frequency of 10^{-5} /year.

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APPENDIX C MAGNET ARC BETWEEN LEADS

During TPX operations, large numbers of neutrons would be generated, producing activated solid material in the vacuum vessel, magnets, and other structural material. Quantities of these activated materials could potentially become mobilized during an off-normal event. The only such event of potential significance in this regard would be a magnet arc between magnet leads(5). A study

has been performed to determine the amount of activated solids that could be mobilized within the test

cell during this event and the resulting whole body dose to the public if all the mobilized material were released up the exhaust stack (Cadwallader and Motloch, 1993). Conservative assumptions were employed throughout to ensure that the results would place an upper bound on the accident consequences. These conservative assumptions include, among others, no credit taken for plate-out within the facility and no credit taken for the substantial reduction of the activation of the magnet material that would result from the presence of the neutron shield. Also the high efficiency particulate air (HEPA) filters in the TPX facility ventilation system were assumed to be degraded and only have an efficiency of 90% (EIS SIS, 1988) as compared to their normal filtering efficiency of 99.97%.

Cumulative specific activity levels were calculated for all the materials under consideration for the magnet including copper, niobium-tin, 316 stainless steel, Inconel 625, and Incoloy 908 (Liew 1993).

The cumulative activation was calculated assuming one year of D-T operations preceded by nine years of D-D operations. For the D-T operation, it was assumed that there would be 4 run periods per year, with 10 shots per day at 75 minute intervals for 5 days per week with a maximum of 700 pulses per year. The nominal TPX D-T pulse consists of 998 seconds of deuterium followed by two seconds of D-T operations. The D-D and D-T neutron source rates for the 998 seconds of deuterium operation preceding the two seconds of D-T operation would be 6.4×10^{16} neutrons per second and 1.3×10^{15} neutrons per second, respectively. During the two seconds of D-T operation, the D-D and D-T neutron source rates would be 1.6×10^{16} neutrons per second and 5.3×10^{18} neutrons per second, respectively (Reiersen, 1993).

5 The presence of coil protection systems, which would detect and isolate faults in the magnet systems, and the grounding of coil cases and structures in the vicinity of the coils makes the occurrence of this event extremely unlikely.

The accident scenario is a magnet arc between magnet leads, resulting in the vaporization of activated magnet material. The study of candidate TPX magnet materials shows that after ten years of TPX operations, Incoloy 908 would be the largest cumulative dose contributor from activated solids for the postulated magnet arc. The maximum stored energy available to volatilize the magnet material would occur when the fault is initiated at the start of a pulse (Neumeyer, 1990)(6). The

resulting maximum stored energy in the magnet is 1,040 MJ. Another 300 MJ of grid energy is conservatively assumed to add to the stored energy in the magnet. Under these conditions, the maximum total energy that could be deposited in the arc is 1.34 GJ, and it is assumed that all of this

energy would be deposited into the Incoloy 908(7). It was assumed that approximately 5.8 MJ is needed to volatilize 1 kg of magnet material in an arc. Therefore, the maximum amount of Incoloy 908 which could be converted to an aerosol is about 231 kg.

A summary of the inventory of isotopes associated with Incoloy 908 potentially contributing to an individual dose at the site boundary and the 50-mile collective dose is shown in Table C-1. The

doses listed in Table C-1 do not account for HEPA filtration. A conservatively assumed degraded HEPA at 90% efficiency would reduce the values in Table C-1 by a factor of ten. (Fully functional

HEPA filters would reduce the dose by 99.97%.) Assuming 90% HEPA filter efficiency, the maximum exposed individual and collective population doses due to a stack release are 5 mrem and 2.2 person-rem, respectively. For a ground level release (ie., severe accident calculation), the corresponding doses are 140 mrem and 21.9 person-rem (Cadwallader and Motloch, 1993).

6 In contrast, maximum activation actually occurs at the end of the pulse. The worst combination of

these two times was assumed for the study.

7 Recent experiments at the Toroidal Energy Storage Experiment (TESPE) facility in Germany indicated

that less than 10% of the energy would actually go into vaporizing the metal (Holland and Lyon, 1989).

To provide additional conservatism, no credit in this analysis has been taken for this potential reduction.

Table C-1. Incoloy 908 Magnet Arc Between Leads

Isotope	half-life	Stack Release		Stack Release	50-Mile
		Dose Conversion Factor	Release	Site Boundary	Collective Dose
	(mrem/Ci released)	(Ci)	Dose (mrem) ¹	(person-rem) ¹	
Na-24	14.97 h	5.58E - 0	0.5	2.9	1.25
Mg-27	9.45 m	1.50E - 2	2.6	0.039	0.017
Al-28	2.25 m	4.60E - 4	15.5	7.1E - 3	3.1E - 3
Cr-51	27.7 d	1.18E - 1	1.3	0.15	0.07
V-52	1.61 m	1.26E - 2	5.2	0.065	0.03

Mn-56	2.58 h	1.37E - 1	7.7	1.0	0.46
Fe-55	2.68 y	4.36E - 2	0.9	0.04	0.02
Mn-57	1.45 m	1.90E - 6	1.0	1.9E - 6	8.8E - 7
Co-57	271.8 d	6.03E - 1	1.8	1.1	0.48
Co-58	70.91 d	3.32E - 0	12.9	43.0	18.8
Co-58m	9.1 h	1.75E - 2	20.6	0.36	0.18
Co-60m	10.48 m	2.00E - 4	5.2	1.0E - 3	5.7E - 4
Ni-57	36.1 h	1.85E - 0	0.6	1.2	0.62
Nb-94m	6.26 m	6.98E - 5	15.5	1.1E - 3	4.8E - 4
			91.3	49.9	21.9

1. Site boundary dose and 50 mile collective dose values in Table C-1 do not show credit for HEPA

filtration. The conservatively assumed 90% HEPA efficiency reduces all table values by 10.

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APPENDIX D

POSTULATED ACTIVATED GAS RELEASE AT GROUND LEVEL FOLLOWING FULL POWER TPX PULSES

This Appendix shows the dose calculations for a ground level release of all activated air in the test cell immediately following a pulse of the TPX machine. Dose calculations are included for both D-D and D-T pulses. A D-D TPX pulse consists of 3.0×10^{19} D-D neutrons and 6.0×10^{17} D-T neutrons; a D-T TPX pulse consists of 6.4×10^{19} D-D neutrons and 1.2×10^{19} D-T neutrons. The individual effective dose equivalent at the site boundary (D) is calculated from:

where,

A = Radionuclide activity in the test cell atmosphere following a pulse (curies). For test cell activated air, A is given in Appendix A.

CF = Accident conversion factor (mrem/Ci released) for each gaseous radionuclide. These were obtained from Appendix D of the TFTR D-T EA (DOE/EA-0566). The factors corresponding to the ground level release $-/Q$ (4.8×10^{-4} sec/m³) are used.

-r = Radioactive decay constant for the particular radionuclide.

t = Transit time to the site boundary. A value of 120 sec was used (TFTR D-T EA).

Dose calculations were made using the above equation for each gaseous radionuclide, as shown in Table D-1.

Table D-1. Parameter Values and Calculated Doses for Activated Gas Release

Isotope	Activity (Ci)		CF (mrem/Ci)	-r (sec ⁻¹)	Dose (mrem)	
	D-D Pulse	D-T Pulse			D-D Pulse	D-T Pulse
Nitrogen-13	0.13	2.5	8.67×10^{-2}	1.16×10^{-3}	0.01	0.2
Argon-41	0.71	1.8	1.14×10^{-1}	1.05×10^{-4}	0.08	0.2
Nitrogen-16	16	322	4.69×10^{-1}	9.7×10^{-2}	0.00	.001
Chlorine-40	0.16	3.2	3.44×10^{-1}	8.6×10^{-3}	0.02	0.4
Sulfur-37	0.04	0.74	2.80×10^{-1}	2.3×10^{-3}	0.01	0.2
				Total	0.1	1.0

APPENDIX E

STATE OF NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY: COMMENTS AND RESPONSES

This Appendix contains comments and responses resulting from a review of a draft version of this Environmental Assessment (EA) by the State of New Jersey Department of Environmental Protection and Energy (NJDEPE). Included are the NJDEPE comments on the draft EA, responses from the Department of Energy, and a letter of concurrence from the NJDEPE, as listed below.

1. Letter from L. Schmidt (NJDEPE) to M. Krebs (DOE/ER), "Princeton Plasma Physics Laboratory TFTR Decontamination and Decommissioning and the Tokamak Physics Experiment," April 26, 1994.
2. Letter from Milton D. Johnson (DOE-PAO) to Lawrence Schmidt (NJDEPE), "Comments on the Draft Tokamak Fusion Test Experiment (TFTR) Decontamination & Decommissioning (D&D) and the Tokamak Physics Experiment (TPX) Environmental Assessment Under the National Environmental Policy Act (NEPA)," May 11, 1994.
3. Letter from Milton D. Johnson (DOE-PAO) to Lawrence Schmidt (NJDEPE), "NJDEPE Comments on the Draft Tokamak Fusion Test Reactor Decontamination and Decommissioning/Tokamak Physics Experiment Environmental Assessment (EA)," May 20, 1994 (Comment Response Form attached).
4. Letter from Lawrence Schmidt (NJDEPE) to Martha A. Krebs (DOE/ER), "Princeton Plasma Physics Laboratory TFTR Decontamination and Decommissioning and the Tokamak Physics Experiment," May 23, 1994.

State of New Jersey
Department of Environmental Protection and

Robert C. Shinn Jr.
Commissioner

April 26, 1994

Martha A. Krebs
Director
Office of Energy Research
U.S. Department of Energy
Washington, DC 20585

RE: Princeton Plasma Physics Laboratory
TFTR Decontamination and Decommissioning and the
Tokamak Physics Experiment

Dear Ms. Krebs:

The Office of Program Coordination of the New Jersey Department of Environmental Protection and Energy has completed its review of the Environmental Assessment for the Tokamak Fusion Test Reactor (TFTR) Decontamination and Decommissioning Project (D&D) and The Tokamak Physics Experiment (TPX) at the Princeton Plasma Physics Laboratory (EA; March 1994). This review was conducted pursuant to the National Environmental Policy Act.

In general, the EA adequately evaluates the potential adverse environmental impacts which may result from the construction and operation activities associated with the TFTR D&D and TPX projects. However, the Department's Radiation Protection Program has a number of questions concerning compliance of the proposed procedures and operations with a number of technical guidelines and statutory requirements. These questions are listed in Attachment #1.

In addition, please note the following technical comments on the EA:

(1) Section 2.1, page 2-1: states that TFTR D&D activities "would include removal of all tritium storage inventories from the site". To what location(s), and by what route(s), will this tritium be transported? Also, the results of the radiological survey and radionuclide characterization should be submitted to the Department.

(2) Section 2.2.1.2, page 2-11: are there any reasons why the Tritium Purification System should not work as discussed in the EA?

(3) Section 4.1.1.2, page 4-5: what route(s) will be used to transport the estimated 55 shipments per year of waste to Hanford, Washington?

(4) Section 4.2.2.1. page 4-20: states that no modifications are needed to the existing National Pollutant Discharge Elimination System Permits issued to the laboratory. However, given the proposed construction of a new stormwater detention basin, permit modifications may be required. It is recommended you contact the Department's Bureau of Standard Permitting ((609) 292-4860) to clarify the need for any permit modifications.

(5) Section 4.2.3.3. page 4-33: the U.S. Department of Energy and Princeton Plasma Physics Laboratory should continue consultations with the N.J. Department of Environmental Protection and Energy and other appropriate State and local agencies concerning the shipment of all radioactive materials to and from the facility (see Comments #1 and #3). What personnel will be available to provide technical assistance to the Department in responding to and evaluating transportation incidents?

(6) Section 6.2, page 6-4: note that the following additional permits may be required for these projects -

(a) Stream Encroachment Permit

(b) NJPDES Stormwater General Permit (Construction)

(c) Certified Soil Erosion and Sediment Control Plan.

For additional information, please contact the Department's Office of Permit Information and Assistance at (609) 984-0857.

(7) If any soils disturbed during construction of the proposed facilities are contaminated with radioactive materials, they must be managed so that resultant exposures remain within allowable levels. The Department is currently developing appropriate cleanup levels. Allowable radionuclide concentrations in soil would result in incremental (above natural Background) annual doses of 6 mrem for external gamma radiation and 10 mrem from internally deposited radionuclides, incremental indoor radon concentrations of 3 pCi/L, and compliance with the radionuclide standards in the Safe Drinking water act. For additional information concerning these developing standards, please contact Fred Sickels at (609) 987-6367.

Thank you for providing the Department the opportunity to review the EA for these projects. If you have any questions, I may be contacted at (609) 292-2662.

Sincerely,

Lawrence Schmidt
Director
Office of Program Coordination

c. Jill Lipoti, Radiation Protection

Questions Concerning Implementation and Operation of the
TFTR D&D and TPX Proposed Projects

(1) Will the surveys performed during the TFTR D&D project be in accordance with NUREG/CR-5649 "Manual for Conducting Radiological Surveys in Support of License Termination"?

(2) During the TFTR D&D, what will be the acceptable levels for residual fixed and removable contamination to determine that facilities and equipment are adequately decontaminated? Is DOE Order 5400.5 "Radiation Protection of the Public and the Environment Surface Contamination Guidelines" the reference document?

(5) Where are the current and proposed on-site and off-site environmental sampling locations and what media are to be sampled at each location? Will the existing environmental surveillance program be upgraded?

(4) Will the Princeton Plasma Physics Laboratory fully comply with New Jersey Administrative Code Title 7, Chapter 2B, Subchapter 6 (NJAC 7:28-6) "Permissible Dose Rates, radiation Levels and Concentrations" and Subchapter 7, Section 2 (NJAC 7:28-7.2) "Surveys Outside of Controlled Areas"?

Department of Energy
Princeton Area Office
P.O. Box 102
Princeton, New Jersey 08542-0102

MAY 11 1994

Lawrence Schmidt
Director, Office of Program Coordination

New Jersey Department of Environmental
Protection and Energy
Trenton, New Jersey 08625

SUBJECT: COMMENTS ON THE DRAFT TOKAMAK FUSION TEST EXPERIMENT (TFTR)
DECONTAMINATION & DECOMMISSIONING (D&D) AND THE TOKAMAK PHYSICS
EXPERIMENT (TPX) ENVIRONMENTAL ASSESSMENT UNDER THE NATIONAL
ENVIRONMENTAL POLICY ACT (NEPA)

Reference: Subject Letter, Schmidt to Krebs, dated April 26, 1994

Dear Mr. Schmidt:

We wish to thank you for your comments on the subject Environmental Assessment, received by copy of the referenced letter. Per our telephone conversation on May 9, 1994, with Mr. Joel Pecchioli, Program Coordinator, we have drafted the enclosed responses to each of the comments, which we would like to discuss with you and other commenting Department staff members at a meeting at the Princeton Area Office, Monday May 16, 1994 at 10:00 am. Advance copies of our draft responses have been transmitted by facsimile to Mr. Kent Tosch, Radiation Protection, as well as to Mr. Pecchioli.

If after your consideration and discussion at the scheduled meeting, you find that our responses address all of your comments fully and to your satisfaction, we request that you forward a letter stating your acceptance to Ms. Martha Krebs, Office of Energy Research, at our headquarters office, with a copy furnished to me.

If you have any questions, please contact Juris Balodis or Allen Wrigley at (609) 243-3709, and 3710, respectively.

Sincerely,

Milton D. Johnson
Area Manager

Enclosure:
As stated

cc: J. Pecchioli, NJDEPE J. Schmidt, PPPL
K. Tosch, NJDEPE W. White, ESHD-CH
J. Farley, ER-8.2, GTN A. Wrigley, PAO
C. Hickey, ER-8.2, GTN M. Moffitt, PAO
M. Krebs, ER-1, FORS
S. Staten, ER-55, GIN
J. Levine, PPPL

Department of Energy
Princeton Area Office
P.O. Box 102
Princeton, New Jersey 08542-0102

MAY 20 1994

New Jersey Department of Environmental
Protection and Energy
Office of Program Coordination
Attn: Lawrence Schmidt
CN402
Trenton, NJ 08625-0402

SUBJECT: NJDEPE COMMENTS ON THE DRAFT TOKAMAK FUSION TEST REACTOR
DECONTAMINATION & DECOMMISSIONING/TOKAMAK PHYSICS EXPERIMENT
ENVIRONMENTAL ASSESSMENT (EA)

Reference: Letter, 05-16-94, J. Levine to M. Johnson, Same subject

Dear Mr. Schmidt:

Enclosed for your information and action is the referenced letter which addresses all NJDEPE comments on the subject EA discussed at the May 16, 1994, meeting at Princeton Plasma Physics Laboratory with DOE, NJDEPE and PPPL staff. It is our understanding that NJDEPE will send a letter to Martha Krebs of DOE/ER-1 with a copy to me documenting the resolution of all NJDEPE comments by PPPL.

Thank you for your prompt attention to the TFTR/TPX EA document action. If there are any further issues or questions, contact Allen Wrigley at 609-243-3710.

Sincerely,

Milton D. Johnson
Area Manager

Enclosure:

As stated

cc: M. Krebs, ER-1, FORS, w/o encl	C. Hickey, ER-8, GTN, w/encl
J. Pecchioli, NJDEPE "	W. White, ESHD-CH "
M. Moffitt, PAO "	K. Tosch, NJDEPE "
G. Pitonak, PAO "	A. Wrigley, PAD "
J. Levine, PPP "	
N.A. Davies ER-50, GTN "	

[Table](#)

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State of New Jersey

Department of Environmental
Protection and Energy

May 23, 1994

Martha A. Krebs
Director
Office of Energy Research
U.S. Department of Energy
Washington, DC 20585

RE: Princeton Plasma Physics Laboratory
TFTR Decontamination and Decommissioning and the
Tokamak Physics Experiment

Dear Mr. Krebs:

The Office of Program Coordination of the New Jersey Department of Environmental Protection and Energy has reviewed the "response document" (May 20, 1994) prepared by the USDOE Princeton Area Office for the above referenced projects. This document adequately addresses previous Departmental comments on the proposed projects. The Department concurs with the conclusion of the Environmental Assessment prepared for the projects that their construction and operation will not result in significant adverse impacts to the environment.

If you have any questions, I may be contacted at (609) 292-2662.

Sincerely,

Lawrence Schmidt
Director
Office of Program Coordination

c. Kent Tosch, Radiation Protection

Milton D. Johnson. USDOE

[6450-01-P]

U.S Department of Energy Finding of No Significant Impact Proposed Tokamak Physics Experiment Princeton Plasma Physics Laboratory

AGENCY: U.S. Department of Energy

ACTION: Finding of No Significant Impact

SUMMARY: The Department of Energy (DOE) has prepared an Environmental Assessment (EA), DOE/EA-0813, evaluating the environmental effects of using tile existing Tokamak Fusion Test Reactor (TFTR) systems and accessory facilities in the proposed construction and operation of the Tokamak Physics Experiment (TPX) at tile Princeton Plasma Physics Laboratory, Princeton, New Jersey. The purpose of the TPX is to develop fusion energy to compensate for dwindling supplies of fossil fuels and the eventual depletion of fissionable uranium used in present-day nuclear reactors. Proceeding with the TPX is contingent on use of existing TFTR systems and appurtenant facilities. Decontamination and decommissioning of the TFTR is an integral part of the scope of the proposed TPX; therefore, both projects are evaluated in this RA.

Based on the analyses in the EA, the DOE has determined that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA) of 1969, 42 U.S.C. 4321 et seq. The preparation of an Environmental Impact Statement is not required. Thus, the DOE is issuing a FONSI pursuant to the Council on Environmental Quality regulations implementing NEPA (40 CFR Parts 1500-1508) and the DOE NEPA implementing regulations (10 CFR Part 1021).

PUBLIC AVAILABILITY:

Copies of this EA (DOE/EA-0813) are available from:

Milton D. Johnson, Manager
Princeton Area Office, U.S. Department of Energy
P.O. Box 102
Princeton, New Jersey 08542
(609) 243-3700

For further information regarding the DOE NEPA review process, contact:

Dr W. S. White
U.S. Department of Energy
9800 South Cass Avenue
Argonne, Illinois 60439
(708) 252-2101

SUPPLEMENTARY INFORMATION:

DESCRIPTION OF THE PROPOSED ACTION

The proposed action is to use the existing TFTR systems and accessory facilities in the construction and operation of TPX, which would be primarily located inside the existing TFTR Test Cell. The TPX would require dismantlement and removal of all TFTR activated systems within the TFTR Test Cell Complex. Dismantlement and removal of nonradioactive and low activation components in areas such as the Test Cell Basement and the Hot Cell, would start immediately after the conclusion of the TFTR deuterium-tritium experiment, which is expected to conclude in Fiscal Year 1995. Cool-down of the Tokamak in the test cell will commence at that time.

The TPX is being proposed as a national facility for fusion energy research at the Princeton Plasma Physics Laboratory (PPPL). Its primary mission is to develop the scientific basis for an economical, more compact, and continuously operating tokamak in support of the design of a feasible demonstration fusion power plant.

Waste from decontamination and decommissioning would include stainless steel and aluminum structures, piping, copper coils, graphite tiles, solidified radioactive liquids, anti-contamination materials, and concrete rubble. Waste would be packaged into Department of Transportation (DOT) approved containers

and transported to the DOE Hanford site in Richland, Washington, as are current PPPL wastes. Approximately 950 m³ (33,500 ft³) of waste weighing approximately 2270 metric tonnes (2500 tons) would also be disposed.

Construction of a radioactive waste storage building for temporary storage of radioactive waste and final preparation of some radioactive waste shipments would be required. The size of the facility would be approximately 560 m² (6000 ft²), and would be constructed within the existing TFTR facility fence.

A second storm water detention basin similar to and west of the existing detention basin would also be constructed.

Decontamination and decommissioning of the TFTR Test Cell could be completed in approximately 1.5 years, after a 2-year cool-down period. TPX construction would minimally overlap decontamination and decommissioning of TFTR facilities. The TFTR Test Cell Complex would then be available for the TPX approximately 3.5 years after termination of TFTR deuterium-tritium experiments. The total cost for the decontamination and decommissioning of the TFTR is estimated to be \$86 million.

The construction and operation of the TPX would take place within the existing TFTR facility at Princeton Plasma Physics Laboratory (PPPL), with construction scheduled to begin in early FY-1998. The TPX conceptual design is based on

the use of deuterium fuel, but does not preclude the potential upgrade and use of tritium fuel in the final year of operation. Existing TFTR facilities would be adapted and used by the TPX, including TFTR Test Cell Complex; ventilation exhaust vent and intake shafts; mockup building; tritium cleanup/waste handling area; field coil power conversion building; neutral beam power conversion building; radioactive waste systems space; office and technical support space; and miscellaneous PPPL support facilities. In addition to providing space for the TPX, the TFTR Test Cell Complex would provide shielding (via concrete walls, roof, and floor), and provide for confinement and handling of tritium-contaminated and/or radioactive components.

The cost for construction of the TPX is estimated at \$500M (FY-93), with the construction period 1997 to 2000, New facilities to be constructed include TFTR Test Cell building modifications, a new Cryogenic Equipment building, tank yards for water cooling and cryogenic tanks, and a new electrical substation. The Test Cell building modifications would be internal and would not increase the existing external dimensions of the building. The Cryogenic Equipment building would be constructed as a standard industrial single-story building, totaling about 1000 m² (10,800 ft²) The tank yard construction

would include approximately 2,130 m² (22,950 ft²) of new tank yard areas for new gaseous helium tanks, liquid nitrogen storage tanks, water storage tanks, and truck-trailer access. This construction would take place on existing open space. The electrical substation construction would involve installation of a new 138 kV transmission line between the existing substation and the new substation. The new substation would be for transforming 138 kV power to 13.8 kV. A new electric power line would be constructed entirely on PPPL property.

Machine assembly would be scheduled for 1998, with the first operations during 2000. The TPX would be fueled with hydrogen and deuterium plasmas for 10 years; radiation generation would not be significant in terms of neutron activation of components or radiological doses. In deuterium operation, the peak fusion power would not exceed 140 kW. During long pulse deuterium operation, neutrons with energies of 2.45 mega electron volts (MeV) would be the primary neutrons produced, and annual production of these neutrons would be limited to 6.0×10^{21} neutrons. A smaller number of 14.1 MeV neutrons would be produced from deuterium-tritium fusion reactions with tritium produced from the deuterium-deuterium fusion reactions. The number of 14.1 MeV neutrons produced during deuterium operations would be approximately 2% of the number of 2.45 MeV neutrons produced.

The TPX facility would be capable of operating with deuterium-tritium plasmas during the last year of TPX operation. During deuterium-tritium operation, a fully-formed deuterium plasma would be developed (requiring up to roughly 1,000 seconds), into which tritium would be injected. Once tritium has been injected, the device would operate for 2 seconds with a peak fusion power of 15 MW, after which the plasma would be terminated. During the 2 seconds of deuterium-tritium operation, both 2.45 MeV neutrons and 14.1 MeV neutrons would be produced, from deuterium-deuterium and deuterium-tritium fusion reactions, respectively. Production of 2.45 MeV neutrons during deuterium-tritium operation would be approximately 1% of the 14.1 MeV neutron production rate. Operation of the tokamak would be controlled to limit annual neutron production so that the site boundary dose restriction adopted by the project would not be exceeded. The deuterium-tritium phase (if used) would be limited to the last year of TPX operation. Small amounts of tritium, and air activation products would be released, and minor amounts of direct radiation would result from fusion neutrons and activated structural components of TPX.

Low-level solid radioactive wastes generated during TPX operations would consist of contaminated items (e.g., protective clothing) and solidified liquid wastes (tritiated water absorbed on desiccant and solidified liquid

waste from the decontamination area). The volume of waste would be similar to that generated by TFTR operations, which was approximately 7.4 m³ per year for deuterium-deuterium operations, and is projected to increase during deuterium-tritium operations to 28.3 m³ per year (1000 ft³ per year). Wastes generated during TPX operations would be packaged to comply with applicable DOE and DOT requirements and is expected to be shipped to the DOE Hanford Reservation in Washington for disposal, as are current PPPL wastes.

ALTERNATIVES:

Three alternatives were considered: (1) the proposed action, use of the TFTR facilities for the proposed construction and operation of the TPX at PPPL, (2) proposed construction and operation of the TPX at the Oak Ridge Reservation in Tennessee, and (3) no action. Location of the TPX at the Oak Ridge Gaseous Diffusion Plant, near Knoxville, Tennessee, would require construction of new support facilities including a new test cell, hot cell, waste handling and storage areas, field coil power conversion building, and cryogenic facilities. The additional cost and time would jeopardize the U.S. fusion program and make the TPX project infeasible. Under the no action alternative, decontamination and decommission of TFTR facilities would occur under current management practices, but may involve a longer delay between safe shutdown activities and

commencement of decontamination and decommissioning activities. The longer delay would not fit within the current schedule to meet the construction of the TPX. This delay may in turn be followed by a 2-3 year period of delay, during which the TFTR facility would be in a state of protective custody. The TPX would not proceed under the no action alternative.

ENVIRONMENTAL IMPACTS:

The impacts of the TFTR decontamination and decommissioning and TPX construction and operation on the environment and on the health and safety of workers and the public were analyzed in the Environmental Assessment. Both routine operations and off-normal or accident scenarios were assessed. The Environmental Assessment considered impacts to air quality, noise, water quality and quantity, aquatic and terrestrial ecology, threatened and endangered species, the visual environment, land use, historical and archaeological resources, socioeconomic environment, radiological conditions, and impacts of potential accidents. No significant environmental impacts associated with the proposed action are anticipated.

Activities associated with decontamination and decommissioning of the TFTR would not present any long-term or adverse nonradiological impacts to the public or the environment. It would result in minor impacts, consisting

primarily of commitment of a small area of onsite land for the radioactive waste storage building and the second storm water detention basin.

Construction of the radioactive waste storage building and storm water detention basin may result in a temporary small increase of effluent to Bee Brook, but would not exceed PPPL New Jersey Pollutant Discharge Elimination System permit or other State or federal regulatory requirements.

Potential radiological impacts of TFTR decontamination and decommissioning would not represent potential impacts greater than those from current PPPL operations, which have had no significant consequences. Decontamination and decommissioning activities would result in a dose of less than the adopted design objective of 10 mrem per year to any member of the public from all project sources. It would result in minor releases of activated metal and tritium to the atmosphere and sewer system. The maximum calculated individual public dose would be 2.3 mrem per year, and the increased probability of incremental lifetime cancer risk associated with exposure from this dose would be 1.1 chances in 1,000,000. This very low calculated effect means insignificant risk to the public. Occupational doses would not exceed the PPPT administrative limit of 1 rem per year, which is less than the DOE limit of 5 rem per year.

Operational occurrences during decontamination and decommissioning that could result in the accidental release of tritium, activated gases, or solids consist primarily of component failures and human error, and any releases would be limited by inventories within the components. The largest calculated dose to the public from decontamination and decommissioning accident scenarios, including beyond design basis accidents, is 390 mrem to a maximally exposed member of the public. The increased probability of incremental lifetime cancer risk associated with exposure from this dose would be 195 chances in 1,000,000,

The TPX would not present long-term or adverse nonradiological impacts to the public or the environment at the PPPL site. Other TPX nonradiological impacts would be temporary, except for the commitment of a small parcel of land for construction of new TPX facilities. Construction impacts due to test cell modifications and construction of the cryogenic equipment building, tank yards, and electric substation would be minor. All construction would be built on land already committed to DOE operations. This construction would all be within the current land use restrictions governing PPPL Site agreements with the DOS. For a construction project of this scope, the potential exists for 2.5 lost workday cases (work related injuries that require time-off from

work) over the construction period. Also there would be a 10% increase in the current amount of site traffic, which would increase the potential for on-site vehicular accidents slightly.

Radiological impacts from the TPX would not exceed current impacts from PPPL operations, which has not been shown to cause incremental lifetime cancer risk associated with exposure. Potential environmental, safety, and health radiological impacts were evaluated for both deuterium and possible future tritium operations. Atmospheric releases of tritium and activation products constitute the potential sources of radiological exposure to members of the public. Maximum projected atmospheric releases would result in annual effective dose equivalents of 1.2 mrem and 4.6 mrem to a hypothetical maximally-exposed individual at the site boundary during deuterium and tritium operations, respectively, with a maximum increased probability of incremental lifetime cancer risk associated with exposure of 2.3 chances in 1,000,000. These conservatively-calculated effective dose equivalents are less than the most restrictive limit for public doses caused by airborne releases (the EPA limit of 10 mrem per year). Direct radiation from the TPX would be mitigated with shielding to keep the total effective dose equivalent from all sources at the site boundary within the project design objective of less than or equal to

10 mrem per year. This design objective effective dose equivalent is well below the DOE limit of 100 mrem per year to members of the public from routine DOE operations.

Normal TPX deuterium-tritium operations would result in total estimated collective effective dose equivalents of 7.5 person-rem per year and 24 person-rem per year to the projected population within the 80 km (50 mi) radius area surrounding PPPL during deuterium and tritium operations, respectively. These doses amount to an average affective dose equivalent of less than 0.002 mrem per year to each individual in the assessment area and would result in less than 1 health effect in the exposed population. On the basis of the collective effective dose equivalent, incremental lifetime cancer risk associated with exposure attributable to TPX operations are not expected to occur. A collective effective dose equivalent of 24 person-rem per year represents approximately .002% of the collective effective dose equivalent from natural background radiation in the area (exclusive of radon).

Occupational doses to workers during TPX operations would result from direct radiation and small releases of tritium and activated gases. Operational procedures, administrative controls and monitoring would ensure that occupational doses are kept below regulatory limits and as low as reasonably achievable.

Accidental releases of radioactive material could hypothetically result from (a) natural phenomena (e.g., earthquakes), (b) accidents with external origin (e.g., airplane crashes), (c) shipping accidents (i.e., accidents involving the transportation of radioactive material), and (d) operational occurrences (e.g., tritium leaks). All TPX confinement boundaries would be capable of maintaining integrity for design basis natural phenomenon, and therefore a release due to a natural phenomena event is extremely unlikely.

Accidents with external origins and transportation accidents involving small quantities of radioactive material would present little risk to the public and the environment. Transportation accidents involving larger quantities of radioactive material, for example tritium, could occur; however, the accidental release of significant quantities of radionuclides has a very low probability because of the demonstrated integrity of the approved containers that would be used.

TPX operational occurrences that could result in the accidental release of tritium, activated gases, or solids consist primarily of component failures and human error. Releases associated with these occurrences would be limited

by component inventories. The maximum calculated individual dose from accident scenarios is 390 mrem, which is well below the DOE siting guideline limit of 25 rem. Incremental lifetime cancer risk associated with exposure resulting from the collective doses would represent a negligible increase in the total number of such health effects in the exposed population from all natural background radiation doses. The largest potential radiological impacts to the public from TPX accidents, including beyond design basis accidents, are below regulatory limits.

After TPX operation has ended, a proper NEPA review would be conducted for the decontamination and decommissioning of the facility. It is expected that the waste material resulting from decontamination and decommissioning activities would qualify as low-level radioactive waste and would be disposed of at an appropriate DOE waste disposal facility.

TFTR operations would be discontinued prior to TFTR decontamination and decommissioning. Cumulative effects would be minor and would represent a continuation of, rather than a change in, any impacts (negative and positive) associated with TFTR operations. Commitment of 560 m² (6,000 ft²) of land for the construction of the radioactive waste storage building and 1,300 m²

(14,000 ft²) for construction of a second storm water detention basin would represent a long-term commitment of land use. Environmental releases of small amounts of residual tritium during decontamination and decommissioning would not add measurably to current low levels.

CUMULATIVE AND LONG TERM IMPACTS:

There are currently no measurable cumulative impacts occurring between PPPL and other facilities in the region, and none would be expected for the proposed TPX. Releases of radionuclides to the atmosphere by commercial operations (such as hospitals and research laboratories) near PPPL are not detectable in environmental samples collected around PPPL; analyses show no radionuclide concentrations above background levels. No adverse long-term environmental effects are expected from normal operations of the TPX. Tritium releases during normal operations would not constitute a measurable contribution to background radiation levels, because of the small amount of tritium to be released, its relatively short half-life (12.3 years), and rapid dispersion in the environment.

DETERMINATION:

Based on the analyses in the Environmental Assessment, the DOE has determined that the proposed action at the PPPL is not a major Federal action

significantly affecting the quality of the human environment within the meaning of the NEPA, consequently, an environmental impact statement is not required.

Issued in Argonne, Illinois, this 5th day of December, 1994.

Cherri J. Langenfeld
Manager
Chicago Operations Office