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ENVIRONMENTAL MONITORING REPORT
FOR CALENDAR YEAR 1985

By

J.R. Stencel

MAY 1986

PLASMA
PHYSICS
LABORATORY

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PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY,
UNDER CONTRACT DE-AC02-76-CNO-3073.

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Plasma Physics Laboratory
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Princeton, NJ 08544

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ENVIRONMENTAL MONITORING REPORT
FOR CALENDAR YEAR 1985

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ABSTRACT

The results of the environmental monitoring program for CY85 for the Princeton Plasma Physics Laboratory (PPPL) are presented and discussed. All of the tokamak machines, the Princeton Large Torus (PLT), Princeton Beta Experiment (PBX), and the Tokamak Fusion Test Reactor (TFTR), had a full year of run time. In addition, the S-1 Spheromak and the RF Test Facility were in operation. The phased approach to TFTR environmental monitoring continued with the establishment of locations for off-site monitoring. An environmental committee established in December 1984 reviewed items of environmental importance. During CY85 no adverse effects to the environment resulted from any operational program activities at PPPL, and the Laboratory was in compliance with all applicable Federal, State, and local environmental regulations.

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1.0 INTRODUCTION

1.1 General

This report gives the results of the environmental monitoring program at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Year 1985 (CY85). The report is prepared to provide the U.S. Department of Energy (DOE) and the public with information on the level of radioactive and nonradioactive pollutants, if any, added to the environment as a result of PPPL operations. The objective of the environmental monitoring report is to document evidence that DOE facility environmental protection programs adequately protect the environment and the public health.

PPPL has engaged in fusion energy research since 1951 and currently has three large tokamak devices in operation; namely, the Princeton Large Torus (PLT), the Princeton Beta Experiment (PBX), and the Tokamak Fusion Test Reactor (TFTR). The PBX was shut down at the end of 1985 to undergo modifications (PBX-M) and is expected to be back in operation in the spring of 1987. In addition, the S-1 Spheromak, which began operation in CY83, continued on a course of operations and upgrade during 1985. The goal of the Magnetic Fusion Energy Research Program is to develop and demonstrate the practical application of fusion energy.

The Spheromak is a compact toroidal concept. The S-1 (Fig. 1) achieved its initial goal of producing hot (100 eV) plasmas with lifetimes of 1 msec or more. With toroidal currents of over 300 kA, electron densities in the mid to upper 10^{13} cm⁻³ range and with higher operating currents of over 500 kA, the future looks good for producing electron temperatures in the 200-300 eV range. Furthermore, a new current transformer will be installed in the near future to increase the plasma current into the 1 megamp (MA) range. The S-1 has no expected potential for impact on the environment, a conclusion that is documented in its Safety Assessment Document (E184).

Another small device, the Radio Frequency Test Facility (RFTF) began operation in CY84 (Fig. 2). RF wave launcher testing for PLT operations and for future TFTR operations were undertaken in 1985. In addition, feasibility studies were done on the use of plasma arcs to disassociate chemical compounds. The conclusion of the RFTF Safety Assessment Document was that the device will have no effect on the environment (Na34). This has proven to be the case in its operations to date.

The PLT (Fig. 3) had another successful year after setting a new RF heating record in 1984. After the success with the Ion Cyclotron Heating, PLT dedicated much of its time to Lower Hybrid Current Drive (LHCD) experiments. By driving currents in the core of the

plasma, LHCD has been successful in suppressing the sawteeth with moderate power. By further increasing the RF power, the central electron temperature increased to 5 keV. Also, preliminary experiments on Ion Bernstein Wave Heating showed very promising results in ion heating.

The PBX (Fig. 4) after achieving a $>5\%$ beta (ratio of plasma pressure/magnetic pressure) in CY84, established a routine operating scheme in 1985 to access this higher beta regime. This operation has revealed high ion temperatures of 4.5 - 5 keV at 5% beta, even with toroidal fields as low as 9 kilogauss. A Safety Assessment Document for PBX published in 1984 indicated that the PBX does not pose any potential environmental concerns (F184). At the end of 1985 the PBX was shut down for modifications and is expected to be back on line in the spring of 1987.

The TFTR (Fig. 5), which had its first full year of running in CY83, increased the total neutron production in CY85 to a level where radioactivity can be detected from activation of the vessel after major run periods. The TFTR is a toroidal device in which a deuterium-tritium (D-T) plasma will be magnetically confined and heated to extremely high temperatures by neutral beam injectors. A major achievement in 1985 was the operation of the TFTR at its design magnetic field

strength of 5.2 Tesla (52 Kilogauss) and design plasma current of 2.5 MA. The eventual goal is to produce a D-T fusion reaction which will yield an output of fusion energy equal to the energy required to heat the plasma. As a result of fusion program budgetary constraints, the planned introduction of tritium into TFTR will be delayed from 1986 to 1989. The potential hazards of this program are addressed in Safety Analysis Reports (PSAR78 and PSAR82).

Because the PPPL site is, in general, open to the public, this free access has necessitated a thorough evaluation of the on-site discharges as well as the potential for off-site releases of radioactive or nonradioactive effluents. Thus, an extensive monitoring program tailored to these needs has been instituted and expanded over recent years. The PPPL environmental radiological monitoring program generally follows the guidance given in DOE reports A Guide for: Environmental Radiological Surveillance at U.S. Department of Energy Installations (Co81) and Environmental Dose Assessment Methods for Normal Operations at DOE Nuclear Sites (PNL-4410) (St82). This includes adherence to the standards given in DOE Orders, in particular, DOE Order 5480.1, Chapter XI (DOE81), which pertains to permissible doses and concentration guides, and gives guidance on maintaining exposures "to as low as reasonably achievable" (ALARA). Specific criteria for implementing these standards on TFTR are contained in a

TFTR Operational Safety Requirement (OSR/TFTR/D-2F-C) (see Table 1). This OSR has had approval to add the Environmental Protection Agency (EPA) 25 mrem per year airborne radionuclide requirements in 1986.

The emphasis of the monitoring program has been placed on exposure pathways appropriate to fusion energy projects. These pathways include external exposure from direct penetrating radiation and eventually airborne isotopes, such as ⁴¹Ar, ¹³N, ¹⁶N, and internal exposure from isotopes, such as ³H in air and water. Seven major critical pathways were considered (see Table 2). Prompt radiation was also considered and is measured. The monitoring program as envisioned by the TFTR Final Safety Analysis Report (FSAR82) is noted in Table 3. Because of the lack of any significant number of fish in water flowing from the facility and the absence of local dairy farms, DOE has approved the use of alternative foodstuffs, e.g., honey, spinach, etc. At present, the radioactive pollutant potential by any pathway to the environment is essentially nonexistent. Small amounts of tritium produced from D-D reactions is not measurable outside the TFTR vessel.

Preliminary meteorological considerations and associated methodology, which were established at the time of the installation of PPPL's first meteorological tower, were reported in Section 14 of the TFTR FSAR. Subsequently, improved methodologies were implemented and a new

meteorological tower was installed and began operation in November 1983 (Mc83). The first-year wind rose data of this new system were presented in last year's report (Ko85). Data for 1984-85 are shown in Figs. 6 and 7 (Ko86a). Tritium use, other than for system testing, will be delayed until 1989. The FSAR will be amended for tritium operation and will include changes since its original publication, including any update with respect to new meteorological and demographic data.

1.2 Description of the Site

PPPL is located at the James Forrestal Research Campus of Princeton University. As shown in Fig. 8, the location is in central New Jersey within Middlesex County. The site has undisturbed areas with virgin forest, open grass areas, an airplane runway, and a small brook running through its eastern boundary. The closest urban centers are New Brunswick, 14 miles to the northeast and Trenton, 12 miles to the southwest. Major metropolitan areas including New York City, Philadelphia, and Newark are within 50 miles of the site. As shown in Fig. 9, the municipalities of Princeton, Plainsboro, Kingston, Penns Neck, Princeton Junction, and Cranbury, among others, are in the immediate vicinity of the site. Also, the main campus of Princeton University, located primarily within the borough of Princeton is approximately three miles to the west of the site. The general layout of the facilities

at the Forrestal Campus is indicated in Fig. 10, where the specific location of TFTR is denoted as D-site.

Figure 11 and Table 4 indicate the 1974 population estimates in sectors within ten miles of PPPL. Table 5 and Fig. 12 show the projected population for 1985. This was derived by the New Jersey State Office of Business Economics in the Department of Labor and Industry who calculated the percentage increase projected for municipalities in the zero-to-ten-mile region. The resident population within 10 to 50 miles of PPPL, based on the 1970 census, is shown in Table 6. The site is in the center of a highly urbanized region from Boston, Massachusetts to Washington, D.C. The 1985 population projections for the states of New Jersey, New York, and Pennsylvania indicate a substantial population increase within 50 miles of the PPPL site. The actual change from 1970 to 1980, as indicated by the census in these two years, was not as much as expected. In fact, the population in New York City and Philadelphia decreased. The Princeton area continues to experience a substantial increase in new business moving into the Route 1 corridor near the site. The increase, however, has not been as much as the projections indicated. Because of delays in the tritium program, a new demographic study

was also delayed until CY88. An internal study on population distribution was done in 1985 (St85b), but was not expanded to cover the detail of annular regions and sectors (Tables 7-13). Preliminary sector data are now available (Ko86b).

2.0

SUMMARY

During CY85 there were no accidents, incidents, or occurrences that had an impact on PPPL facilities, program operations, or the environment. A small oil spill occurred requiring disposal of 10 cubic yards of dirt. Weed control and grass fertilization were applied under the direction of the Princeton University Building and Grounds Department. The work was done by University personnel or certified contractors in accordance with EPA regulations. Transformers and capacitors containing PCB oils are being removed from service and disposed of in accordance with prepared schedules and EPA regulations. The Laboratory has a program to monitor, inventory, and dispose of PCB and other potentially toxic materials. An assessment of the closure of the old sewage disposal plant at C-site was accomplished to document that the plant had been operated and closed in an environmentally acceptable manner (St85a).

Surface water analyses for both radioactive and nonradioactive pollutants have not shown anything above

normally expected background values. The initial phase of a program for ground water analysis was initiated in 1985 and will continue into 1986. Initial tritium analysis indicated levels on the order of 100 pCi/l (3.7 Bq/l). These data are in agreement with the old on-site drinking water wells. Soil and vegetation samples were collected and analyzed as part of our baseline studies.

Radiation exposure either via prompt or airborne radioactivity to the environment is still essentially immeasurable under present operations. Prompt radiation, however, was detectable through the TFTR shield walls for the higher power pulses. Some activation of the vessel was noted after a full day of operations. Additional wall shielding was added to the TFTR test cell in mid-1985 in preparation for higher radiation levels projected for the tritium experiments scheduled for 1989.

At PPPL's request, the radiological environmental collection and analysis procedures were reviewed in CY85 by the Idaho National Engineering Laboratory (INEL). In addition, off-site monitoring locations were discussed. A program was initiated to provide monitoring stations to establish baselines, even though future off-site exposure potential is expected to be essentially nonexistent.

3.0 MONITORING, ENVIRONMENTAL PROGRAM INFORMATION, DATA COLLECTION ANALYSES, AND EVALUATION

The monitoring program implementation has followed a phased approach commensurate with the potential hazards and the needs of an expanding program. Nonradioactive water pollutant monitoring has been conducted for many years. A more extensive program, which began in 1979, presently includes eight surface water sampling points (four on-site and four off-site), two old on-site wells, and the potable water supply source. Monitoring for sources of potential radiological exposures is quite extensive. Real-time prompt gamma/neutron environmental monitoring began on the TFTR site in 1981 to establish baselines prior to machine operation. The original station (RMS-B) is located on the TFTR site, approximately 200 feet from the TFTR torus and 200 feet from the present northwest perimeter fence (see Fig. 13). Four monitoring stations have been located at the TFTR exclusion zone boundary (EZB). Neutron monitors were added at these locations at the end of CY84. Radiological water samples are being collected at the same locations as the nonradioactive sample points (see Figs. 13 and 14).

3.1 Radioactivity

3.1.1 Penetrating Radiation

Operation of the Princeton Large Torus (PLT) and the Princeton Beta Experiment (PBX) results in the production of some penetrating radiation (primarily bremsstrahlung X rays and neutrons). Because neither the PLT nor PBX have a roof shield, skyshine radiation (primarily neutron) is seen at the TFTR baseline site monitoring station (RMS-B, Fig. 13). The shielding installed for the PLT/PBX machines has kept the total exposure dose equivalents in occupied areas below occupational exposure guidelines. Skyshine radiation from neutron production of PLT and PBX added a few mrem to the D-site environs, but overall site boundary radiation from all devices was less than 1 mrem (0.01 mSv) (G186). Actual personnel exposure is much less than any of these values since no individual occupies these areas during all, or even a large fraction of PLT or PBX operations.

The stated Laboratory policy is that when occupational exposures have the potential to exceed 1000 mrem/yr (10 mSv/yr), the appropriate project manager must petition the PPPL Executive Safety Board (ESB) for an exemption. In addition, the Laboratory applies the DOE ALARA policy to all its operations. This philosophy for occupational exposure means that environmental radiation

levels, as a result of experimental device operation, are also very low, and acceptable.

The design objective for TFTR is to stay below 10 mrem/yr (0.1 mSv/yr) above natural background from all sources of radiation at 125 meters from the machine. The TFTR, like other tokamaks, produces bremsstrahlung X radiation from the electrons at the end of a pulse. These X rays, in the range of 0 to 20 MeV, also produce photoneutrons. Injection of deuterium neutral beams began at the end of CY84. With these D-D runs the neutron fluxes increased in CY85. While the total neutron production during CY84 was on the order of 10^{15} , the daily runs in early CY85 reached this value. The total neutron production for the year from TFTR was on the order of 5×10^{16} . Additional shielding was added to the TFTR test cell walls in the middle of CY85. No significant penetrating radiation was added to the environs due to TFTR operations in 1985. Radiation levels (μ R) were recorded for some pulses outside the Test Cell, with the total exposure dose equivalent at the TFTR site boundary (EZB) being less than 1 mrem (0.01 mSv) for CY85 (Gi86).

The TFTR site boundary monitors are Reuter-Stokes Senti 1011 pressurized ionization chambers and He-3 moderated neutron detectors. The electronics in the ionization chambers were modified to allow the integration of any prompt radiation resulting from a TFTR machine pulse

that may be above natural background. These data are stored and processed as part of the Central Instrumentation Control and Data Acquisition (CICADA) computer system. Four of these monitoring stations are placed at the EZB (125 meters from the TFTR) (see Fig. 13). Another eight ionization chambers of lower sensitivity are located nearer the TFTR device (four outside the test cell wall, three in the basement, and one on the roof). These eight detector locations are for personnel safety and are not considered environmental detectors per se. However, data collected from these monitors are used to help correlate environmental measurements. Besides the moderated He-3 neutron detectors, Bonner-type-moderated Li(I) detectors were used for monitoring at various locations throughout the TFTR facility. At the end of 1984, He-3 moderated neutron detectors were placed at the same locations around the test cell as the above-mentioned eight ionization chambers. Figure 16 notes the net environmental gamma and neutron measurements for CY84-85. These data essentially confirm the natural background levels expected in this part of New Jersey.

3.1.2 Special Surveys (St81)

In August 1980, EG&G, Inc., under DOE contract, conducted an aerial radiological survey of PPPL and surrounding areas. The detection system used consisted of 20 sodium iodide detectors, a multichannel analyzer, and a magnetic tape recording system. The nominal exposure rate range observed was eight to ten uR/hr. Detected radioisotopes were consistent with normal background emitters.

3.1.3 Airborne Radioactivity

Radioactivation of air and tritium in measurable concentrations is not expected until TFTR D-T operations. A real-time prototype baseline air and particulate monitor has been in use since the beginning of CY82. This system consisted of two CaF(Eu)NaI(Tl) phoswich detectors which used pulse shape and time variations to give gross alpha, beta, and gamma information. A calibration was accomplished for beta detection using a Xe-133 gas source. The experience gained with this system, led to the conclusion that a simple beta scintillator will provide adequate information. In 1985 an initial air and particulate monitor using a beta detector was procured for installation at the EZB. This detector will undergo calibration, checkout, and installation during 1986.

A prototype differential tritium air monitor using an ethylene glycol bubbler concept was found to be inadequate for environmental monitoring. A modified silica gel system is under test (Gr85) and will be deployed to provide baseline data in concert with the new tritium schedules.

As part of our expanding environmental program and at PPPL's request, a review of our environmental radiation program and the possible use of available off-site monitoring by outside organizations was done by the Idaho National Engineering Laboratory (INEL) in CY84-85. Most of the off-site monitoring stations belonging to outside utilities and located in the direction of the prevailing winds were deemed to be too far away and therefore not useful to our program. It was suggested that several simple off-site tritium and air particulate monitoring stations be set up in local communities to provide a baseline data base to reference our expected minimal release during operations with tritium. A silica-gel-type monitor is under test for this option. The optimal locations for these detectors were identified in 1985 (see Fig. 15).

Meteorological data had been collected on-site at the original station since 1977. Lakehurst Naval Air Station data were also acquired and were the primary data used in the meteorological calculation (X/Q) for the TFTR FSAR. Discussion on the problems of wakes

caused by airflow patterns near buildings led to a reevaluation of the meteorological data collected on-site. In November 1983 a three-level, 60 meter tower was installed for gathering meteorological data. The new wind rose data for two years of operation are shown in Figs. 6 and 7. Preliminary analysis indicates that the site is dominated by neutral to moderately stable conditions with moderately unstable to extremely unstable conditions occurring less than a few percent of the time. Average surface winds are about 2.1 m/s and rise to about 4.1 m/s at 60 m (Xo86a). Based on data from this new tower, X/Q values will be recalculated for the tritium addendum to the FSAR before TFTR tritium operations.

3.1.4 Waterborne Radioactivity

3.1.4.1 Surface Water

Surface water samples at eight locations (four on-site, four off-site) have been analyzed for tritium, gamma radioisotopes and gross alpha and beta activity. Five of these locations have been monitored since CY82. Downstream sampling occurs after mixing of effluent and ambient water is complete. Locations are indicated on Figs. 13 and 14.

Sample analysis has shown no unusual background radioisotopes. Tritium analysis by liquid scintillation methods has shown tritium values to be less than 100 pCi/l (3.7 Bq/l) on all samples analyzed to date. Tritium enrichment procedures can be used to see lower levels and are presently used for some samples. Rain water samples collected and analyzed in 1985 ranged from 45 to 160 pCi/l but averaged out to the surface water levels of approximately 100 pCi/l (3.7 Bq/l).

3.1.4.2 Ground Water

Two existing on-site wells (W4 and W5) were sampled in CY85 (see Fig. 13). As part of our phased approach, a more comprehensive ground water program was initiated in June 1985 through the U.S. Geological Survey. This program entails drilling several monitoring wells on the TFTR site in order to help profile the ground water system. The initial radioactive analysis for tritium was done by PPPL and the University of Miami under a USGS sampling program. The split sample results were consistent and indicated tritium levels as being less than 100 pCi/l (3.7 Bq/l).

3.1.4.3 Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. In April 1984 a sample point at the input to PPPL was established (El location, Fig. 13) to provide baseline data for water coming onto the site. Radioactive analysis has included gamma spectroscopy, tritium, and gross alpha and beta.

3.1.5 Foodstuffs

Because there are so few dairy farmers in this area, milk is not a viable analysis medium around the site. Also the fish population is very scarce or nonexistent in Ditch 5 and Bee Brook, which carry the runoff from the site. DOE has agreed that a substitute of vegetables and honey available from local surroundings should be used. Sampling in 1985 indicated tritium levels below 100 pCi/l (3.7 Bq/l).

3.1.6 Soil, Grass, Vegetation

Sample locations off-site were established in late 1985 (see Fig. 15). Soil and grass samples collected on-site in 1985 indicated tritium levels below 100 pCi/l (3.7 Bq/l). Laboratory techniques for doing these analyses were perfected in CY84 (Gr85). Surface soils and vegetation are among the best indicators of tritium after a release (Jo74) (Mu77), (Mu82).

3.2 Nonradioactive Pollutants

3.2.1 Airborne Effluents (Ki86)

PPPL has a New Jersey Department of Environmental Protection (NJDEP) Permit for its C-site boilers and fuel tank vents. The seven permit certificates numbered 061294 through 061300, expire in March 1987. Application for new permits will be initiated in October 1986.

Measurements of actual emission are not required. Emissions are calculated using formulae supplied by the New Jersey Department of Environmental Protection (NJ/DEP).

3.2.2 Water Utilization (Ki86)

3.2.2.1 Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. PPPL (C-site) uses approximately 55 million gallons per year. Water quality analysis at the input to PPPL was initiated in CY84 for both radioactive and nonradioactive pollutants (Table 13).

3.2.2.2 Process (nonpotable) Water

Nonpotable water is pumped by PPPL from the Delaware & Raritan Canal which is authorized by a permit agreement with the New Jersey Water Supply Authority. This agreement gives PPPL the right to draw up to one million gallons of water per day for process and fire fighting purposes for the period beginning July 1, 1984 and ending on September 30, 1991. Treatment consists of filtration to remove suspended solids. This sampling point was established to provide baseline data for process water coming on-site. Table 16 indicates results of water quality analysis at the canal.

3.2.2.3 Storm Sewage

Storm sewage that includes cooling tower and boiler blowdown is discharged into surface waters. D-site storm sewage additionally goes through a retention basin. National Pollution Discharge Elimination System (NPDES) Permit No. NJ0023922, defining control for these effluents, became effective 11/1/84 and expires on 10/31/89. Quarterly water chemistry reports compiled from the data in Table 18, were submitted to the State of New Jersey in 1985 in accordance with NJ/DEP requirements. Of the data submitted, only one parameter

(total solids) exceeded the limits on one occasion. This was due to the fact that the sample was taken after a heavy rain where runoff increased the amount of the dirt in the water.

Cooling water treatment was changed from a chromate-based corrosion inhibitor to a nonchromate inhibitor in June 1983. Water analyses downstream (see Tables 14-24) have not indicated concentrations of any environmental pollutants above applicable codes, regulations, or standards. An improvement to the retention basin was scheduled for CY85 and is now expected to be finished by mid-1986. Storm sewage waters from the active areas of C-site as well as D-site will then flow through the retention basin. A Spill Prevention Control and Countermeasures (SPCC) Plan update was received from an outside A/E firm in January 1985. The action items listed in this plan to satisfy Federal regulations on pollution prevention (40 CFR part 112) are complete except for the retention basin modification.

3.2.2.4 Sanitary Sewage

Sanitary sewage is discharged to the publicly owned treatment works operated by South Brunswick Township at Stony Brook. Flow rates are measured by the PPPL sanitary sewage metering station and average approximately 62,000 gallons per day. Sampling of PPPL discharges, done by the publicly owned treatment works,

has determined that pretreatment is unnecessary. Therefore, PPPL is in compliance with the EPA Pretreatment Standard, 40 CFR part 403.

3.2.3 Special Surveys (St85a)

The closure of an old sewage treatment plant was reviewed in some detail in 1985, including the sampling of soil. It was concluded that the site was operated and closed in an environmentally acceptable manner.

3.2.4 Oil Spill

A small oil spill was detected in the wooded area near the old sewage plant in January 1985. Ten cubic yards of oily dirt and debris were removed and shipped off-site by a certified contractor for such disposal on January 15, 1985. Because of the prompt action taken, no damaging effects to the environment were noted.

3.2.5 Herbicides, Fertilizer, and Pesticides (C186)

The use of herbicides, pesticides, and fertilizers is not controlled by PPPL but by Princeton University's buildings and grounds maintenance personnel. These materials are applied in accordance with State and Federal regulations. Herbicides are applied by a certified applicator. Table 25 lists the quantities applied during CY85.

3.2.6 Polychlorinated Biphenyls (PCB's)

Beginning in CY82 PPPL started a program to dispose of PCB containing capacitors, transformers, and contaminated items. All stored items in a GSA Warehouse in Belle Mead, New Jersey were discarded through approved disposal contractors during the early phases of the program. Remaining PCB items were labeled, as required by EPA regulations, and an inventory, inspection, and status report program was initiated. A Hazardous Materiel Coordinator was appointed to ensure that any newly identified leaking capacitors or transformers would be handled promptly and properly. At the beginning of CY84 PPPL still had 15 PCB transformers and 6005 large capacitors containing PCBs. In CY84 375 large and 54 small PCB capacitors were disposed of as well as the oil and flushed containers of two transformers (Ho85). In 1985, an additional 1330 capacitors and 22 small capacitors were properly discarded (La86). Other PCB capacitors are being disposed of as they are taken out of service. Transformer replacement has been initiated and is scheduled to meet the EPA requirements.

3.2.7 Hazardous Wastes

Significant progress was made starting in CY82 with respect to identification, collection, and disposal of hazardous waste in an environmentally acceptable manner and in accordance with EPA requirements. Waste disposal manifests are filed as required by the NJ/DEP, Division of Waste Management. Responsibility for this program rests with the PPPL Hazardous Materiel Coordinator, under the Materiel Control Office. A facility was set up in CY82 for temporary storage of hazardous materials. The area includes an enclosed and covered area with a concrete containment, fire and security alarms, fire extinguishers, an eye wash, one emergency shower, and telephones. A contract has been awarded for the construction of a new hazard waste facility. Construction is anticipated to be completed by early FY87.

The hazardous waste generator annual report (EPA ID number NJ1960011152) has been submitted for 1985 in accordance with EPA requirements.

3.3 Environmental Impact

3.3.1 Assessment of Radiation Dose to the Public

PPPL is located in one of the less densely populated areas in the metropolitan region between New York City and Philadelphia. Previous census data indicate that approximately 16 million people live within 80 km (50 miles) of the site, and approximately 225,000 within 16 km (10 miles) of PPPL. This detailed distribution of population as a function of distance is given in Tables 4-13. Because of ever-increasing commercial growth in this area, a demographic update was planned for CY85. However, because of delays in the start of TFTR tritium operations, it was decided that this update should be delayed in order to obtain the most relevant data.

The overall exposure dose equivalent from all sources at the PPPL site boundary was estimated to be less than 1 mrem for CY85 (G186). Detailed person-rem calculations for the surrounding population were not performed, because the value would be insignificant in comparison to the approximately 100 mrem (1 mSv) each individual receives from the natural background in New Jersey.

3.3.2 Assessment of Nonradioactive Pollutants

There were no activities during CY85 that created problems with respect to nonradioactive pollutants. A small oil spill was detected and cleaned up with no significant environmental impact.

Polychlorinated biphenyls (PCB's) continue to be disposed of in accordance with EPA requirements. Herbicides, pesticides, and fertilizers were used in very limited quantities and are not expected to have any noticeable negative impact on the environment.

4.0 QUALITY ASSURANCE FOR LABORATORY ANALYSIS IN CY85

Analysis of water samples for radioactivity was accomplished in-house. In general, in-house procedures follow the HASL-300 Manual (Vo82). PPPL participates in the EPA (Las Vegas) program as well as a program provided by the DOE Environmental Measurements Laboratory (EML) in New York City. These programs provide blind samples for analysis and subsequent comparison to values of other participants, and to known values. Tritium results are shown in Table 27.

During CY84 PPPL initiated a program to have its radiation counting laboratory certified by the State of New Jersey through the EPA QA program. All program requirements have been accomplished and an inspection by EPA/Las Vegas and the State of New Jersey/DEP in March 1986 indicated that tritium procedures will be certified.

Both vendors used in 1985 for nonradioactive water quality analysis participate in a State of New Jersey QA program and have a quality assurance plan (C182 and A185). A blind split sample was also submitted for analysis in 1985 (Table 26).

5.0 FUTURE PROGRAM EXPANSION

5.1 Meteorological

A meteorological tower was installed in November 1983. Data from this system will be used in updating dose calculations for the TFTR FSAR and will also be used in establishing safety-related design requirements for any new D-T device at PPPL. Several dose assessment codes are being used by PPPL with respect to using the data from this tower. These codes include AIRDOSE-EPA, an Ontario Hydro version of TRITMOD, PAVAN, and XOQDOQ.

5.2 Water Quality

The initial phases of a ground water monitoring program began in CY85. Water sample analysis will be added to both the radioactive and nonradioactive programs from these wells.

5.3 Radioactive Effluents

5.3.1.1 Air Gaseous and Particulate

Based on collected data, a decision was made in CY84 to limit the specific air and particulate monitors to a beta detector only. One of these systems was procured in CY85 and is awaiting calibration and installation. An environmental tritium monitor is presently under test and initial results look promising for deployment in CY86.

5.3.2.2 Off-Site Radiological Monitoring

Off-site grab sample water analysis is now an established program. A program for doing off-site tritium and particulate monitoring, primarily in the direction of the prevailing wind, is being initiated. Initial soil and vegetation samples have been collected and analyzed for tritium. Measurement values were less than 100 pCi/l (3.7 Bq/l).

5.4

Nonradioactive Effluents

Air effluent standards will continue to be met by following the guidelines of the NJ/DEP. Any potential toxic materials will be monitored and disposed of in accordance with applicable regulations and accepted guidelines. The completion of the retention basin scheduled for CY84 should become a reality in 1986. An updated Spill Prevention Control and Countermeasure (SPCC) Plan is in draft form and almost ready for implementation.

6.0

REGULATIONS AND SAFETY CRITERIA

The appropriate Radiation Protection Standard for penetrating radiation was taken from DOE Order 5480.1, Chapter XI. Specific criteria for implementing these standards on TFTR are contained in TFTR Operational Safety Requirements, in particular OSR/TFTR/O-2F-C. The Concentration Guides used in the analyses of surface water samples for radioactivity were taken from DOE Order 5480.1, Chapter XI, Table II, Column 2 (Water in Uncontrolled Areas). The concentration guides for airborne activity will be taken from the same DOE Order, Table II, Column 1 (Concentration in Air in Uncontrolled Areas) for future activities. Tritium, for example, is listed as 2×10^{-7} uCi/ml. The Laboratory was also in compliance with the new DOE draft Order 5480.11. The

Air and Water Pollutions Standards for nonradioactive pollutants were taken from the New Jersey Administrative Code (NJAC), Department of Environmental Protection 7:9-4, et seq. The appropriate regulations for PCB's and hazardous waste are found in the U.S. Code of Federal Regulations, 40 CFR 761 and 40 CFR 260-265, respectively.

7.0

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REFERENCES

- A185 Alinea, E.A., 1985, Princeton Testing Laboratory Quality Control Manual, Princeton Testing Laboratory, Princeton, NJ.
- Ci82 Cirello, J., 1982, Quality Assurance Plan for the PAS Laboratory, Princeton Aqua Science, New Brunswick, NJ.
- Cl86 Clark, G.J., 1/30/86, "Chemical Use," Princeton University Internal Memo.
- Co81 Corley, J.P., et al., 1982, A Guide for: Environmental Radiological Surveillance at U.S. Department of Energy Installations, DOE/EP-023 (National Technical Information Service).
- DOE81 DOE Order 5480.1, Ch. XI, 8/13/81, Environmental Protection, Safety and Health Protection Program for DOE Operations, U.S. Department of Energy, Operational and Environmental Safety Division.
- E184 Ellis, R., Jr. and Stencel, J.R., February 1984, Safety Assessment for the S-1 Spheromak, Princeton Plasma Physics Laboratory Report No. PPPL-2083.
- F184 Fleming, R.B., et al., February 1984, Safety Assessment Document for the Princeton Beta Experiment, Princeton Plasma Physics Laboratory (unpublished).
- FSAR82 Final Safety Analysis Report, Tokamak Fusion Test Reactor Facilities, Princeton Plasma Physics Laboratory, 1982.
- Gi86 Gilbert, J., 1986, "1985 Annual Ionizing Radiation Report," JG-15, Internal Report.
- Gr85 Griesbach, O., and Stencel, J.R., January 1985, "An Environmental Monitoring Program for a Fusion Test Reactor," Proceedings of the 18th Midyear Topical Symposium of the Health Physics Society, Colorado Springs, CO.
- Ho85 Holcombe, S., 1/18/85, "Annual Environmental Report," Princeton Plasma Physics Laboratory, Internal Memo.
- Jo74 Jordan, C.F., Stewart, M., and Kline, J., 1974, "Tritium Movement in Soils: The Importance of Exchange and High Initial Dispersion," Health Physics, 27, 37-43.
- Ki86 Kircher, C., 2/24/86, "Annual Environmental Report," Princeton Plasma Physics Laboratory Internal Memo.

Ko85 Kolibal, J., et.al., June 1985, Meteorological Data Summaries for the TFTR from March 1984 to February 1985, Princeton Plasma Physics Laboratory Report No. PPPL-2223.

Ko86a Kolibal, J., et.al., 1986, Meteorological Data Summaries for the TFTR from January 1984 to December 1985, Princeton Plasma Physics Laboratory Report, to be published.

Ko86b Kolibal, J., private communication, 4/9/86.

La86 Lawson, M., 2/20/86, "Disposal of PCBs in 1985, Plasma Physics Laboratory Internal Memo.

Mc83 McCarthy, E.F., and Errera, L.J., 8/15/83, Final Monitoring Plan: Tokamak Fusion Test Reactor Meteorological Monitoring Program, TRC Environmental Consultants, Inc., 800 Connecticut Blvd., East Hartford, CT 06108.

Mu77 Murphy, C.E., Jr., Watts, J.R., and Corey, J.C., 1977, "Environmental Tritium Transport from Atmospheric Release of Molecular Tritium," Health Physics, 33, 325-331.

Mu82 Murphy, C.E., Jr., Sweet, C.W., and Fallon, R.D., 1982, "Tritium Transport Around Nuclear Facilities," Nuclear Safety, 23, 677-685.

Na84 Nagy, A., and Beane, F., August 1984, Safety Assessment for the RF Test Facility, Princeton Plasma Physics Laboratory Report No. PPPL-2129.

PSAR78 Preliminary Safety Analysis Report, Princeton Plasma Physics Laboratory Tokamak Fusion Test Reactor, 1978.

St81 Steiner, P.A., 1981, An Aerial Radiological Survey of the Princeton Plasma Physics Laboratory and Surrounding Area, U.S. DOE Remote Sensing Laboratory Report, EGG-1182-1806, UC-41.

St82 Strenge, D.L., Kennedy, W.E., Jr. and Corley, J.P., 1982, Environmental Dose Assessment Methods for Normal Operations of DOE Nuclear Sites, PNL-4410/UC-11.

St85a Stencel, J.R., 1985, "Environmental Report on the Closure of the Forrestal Campus C-Site Sanitary Sewage Treatment Plant," Princeton Plasma Physics Laboratory Internal Report.

St85b Strohl, M.E., 9/16/85, "Population Distribution," Princeton Plasma Physics Laboratory Internal Report, MS-928.

Vo82 Volchok, H.L., and de Planque, G., 1982, EML Procedures Manual HASL-300, Department of Energy, Environmental Measurements Laboratory, 376 Hudson St., NY, NY 10014.

TABLE 1

TFTR RADIATION EXPOSURE CRITERIA

The research facility radiation exposure criteria itemized in this table shall be invoked for the TFTR only and shall not be construed as being applicable to subsequent fusion test facilities, research facilities, or reactor projects. The values quoted are for whole body exposures; however, the DOE Manual requirements for other organs (hands, arms, bones, etc.) and other time periods (quarterly) are also applicable to TFTR, and reductions between limits and design objectives shall be consistent with those of the table.

Condition	Off-Site > 125 m		On-Site < 125 m	
	Limit	Design Objective	Limit	Design Objective
Routine Operation mrem/yr [see footnotes (a) and (b)]	500 to an individual	<100 to an individual (b)	500 in an uncontrolled area	<100 in an uncontrolled area
	170 average population member	<35 average population member	5000 in a controlled area	<1000 in a controlled area
Accident rem [see footnotes (c) and (d)]	25	<5 (d)	25	25

(a) Routine operation consists of:

- (1) Normal component operation including shutdown, repair, maintenance, checkout, adjustment, etc.
- (2) Operational occurrences such as leaks, loss of power, and component malfunctions that are likely to occur once or more during the life of the facility.

(b) For normal operation, defined in (a) (1) above, the off-site design objective shall be 10 mrem/year.

(c) Accident conditions consist of:

- (1) Very low probability events such as "most intense predicted" natural phenomena.
- (2) Low probability events such as "most probable" natural phenomena and other component failure events that are not likely to occur during the life of the facility.

(d) For those accident conditions defined by (c) (1) and (2) above, 1 rem.

TABLE 2*
CRITICAL PATHWAYS

<u>Path I.D.</u>	<u>Discharge Pathway</u>
A1	Atmospheric --> Whole Body Exposure
A2	Atmospheric --> Inhalation Exposure
A3	Atmospheric --> Deposition on Soil & Vegetation, Ingestion, Whole Body Exposure
L1	Liquid Water Way --> Drinking Water Supply -----> Man
L2	Liquid Water Way --> External Exposure
L3	Liquid Water Way --> Sediments --> External Exposure
L4	Liquid Water Way --> Fish --> Man

*TAKEN FROM TFTR FSAR TABLE 8.5-1

TABLE 3*

MONITORING PROGRAM COVERING CRITICAL PATHWAYS

TYPE OF SAMPLE	CRITICAL PATH I.D.	SAMPLE POINT DESCRIPTION	SAMPLING FREQUENCY	ANALYSIS
Surface	L1,L2,L4	1)Cooling Water Discharge Drainage 2)Bee Brook Upstream & Downstream 3)D&R Canal	Monthly Composite of Weekly Samples	Gross γ Gross β Isotopic if Necessary
Sediment	L3	Delaware - Raritan Canal	Biennially	Gross γ Gross β
Surface Water	L1,L2	Waste Collection Tanks	As Required By Filling	Gross γ Gross β Rate
Air	A1-A3	Test Cell	Continuous	Gross γ Gross β ^3H (Gas & Water Vapor)
Air	A1-A3	Vault	Continuous	^3H (Gas & Water Vapor)
Air	A1-A3	HVAC Discharge	Continuous	Gross γ Gross β ^3H , particulates
Direct Radiation		4 Locations at Site Perimeter	Continuous	γ , n, ^3H , HTO/ ^3H , particulates

*TAKEN FROM TFTR FSAR TABLE 8.5-2

TABLE 4*1974 POPULATION ESTIMATES WITHIN ANNULAR SECTORS, 0-10 MILES

<u>Sector</u>	<u>TOTAL</u>							<u>Sector</u>
	<u>0-1 Mile</u>	<u>1-2 Miles</u>	<u>2-3 Miles</u>	<u>3-4 Miles</u>	<u>4-5 Miles</u>	<u>5-10 Miles</u>	<u>0-10 Miles</u>	
N	7	430	289	182	164	7,869	8,941	N
NNE	0	22	144	137	3,284	10,353	13,840	NNE
NE	7	58	202	690	274	14,029	15,260	NE
ENE	11	6	0	123	271	9,561	9,972	ENE
E	0	0	55	25	43	11,796	11,919	E
ESE	6	32	63	68	123	3,705	3,997	ESE
SE	3	23	356	29	94	13,511	14,016	SE
SSE	6	2,859	49	27	71	13,837	15,849	SSE
S	0	293	400	570	198	2,839	4,300	S
SSW	0	95	688	1,221	530	26,112	28,646	SSW
SW	0	6	679	43	899	20,690	22,317	SW
WSW	0	394	71	873	253	9,850	11,441	WSW
W	3	835	5,712	5,832	695	7,586	20,663	W
WNW	0	437	2,889	1,455	294	6,788	11,863	WNW
NW	3	198	786	688	221	3,183	5,079	NW
NNW	3	415	259	144	698	2,854	4,373	NNW
TOTAL	49	6,103	12,642	12,107	8,112	163,563	202,575	TOTAL

*TAKEN FROM TFTR FSAR, TABLE 2.1.2-1

TABLE 5*1985 POPULATION PROJECTIONS WITHIN ANNULAR SECTORS, 0-10 MILES

<u>Sector</u>	<u>TOTAL</u>						<u>0-10</u> <u>Miles</u>	<u>Sector</u>
	<u>0-1</u> <u>Mile</u>	<u>1-2</u> <u>Miles</u>	<u>2-3</u> <u>Miles</u>	<u>3-4</u> <u>Miles</u>	<u>4-5</u> <u>Miles</u>	<u>5-10</u> <u>Miles</u>		
N	9	529	355	229	205	9,850	11,177	N
NNE	0	27	177	169	4,041	13,008	17,422	NNE
NE	9	71	248	849	337	7,769	9,283	NE
ENE	16	8	0	151	333	12,406	12,914	ENE
E	1,217	0	74	31	53	13,956	15,331	E
ESE	9	46	1,600	78	144	4,157	6,034	ESE
SE	4	33	4,356	33	108	16,373	20,907	SE
SSE	9	4,117	71	35	82	16,018	20,332	SSE
S	0	548	456	650	226	3,788	5,668	S
SSW	0	137	784	1,392	604	30,893	33,810	SSW
SW	0	9	774	49	1,025	24,987	26,844	SW
WSW	0	552	81	1,126	326	12,765	14,850	WSW
W	683	3,793	6,683	6,823	897	10,252	29,131	W
WNW	0	564	3,611	1,877	379	8,815	15,246	WNW
NW	4	255	1,014	860	263	3,815	6,211	NW
NNW	4	511	326	186	893	3,433	5,353	NNW
TOTAL	1,964	11,200	20,610	14,538	9,916	192,285	250,513	TOTAL

*TAKEN FROM TFTR PSAR TABLE 2.1.2-3

TABLE 6*

1970 RESIDENT POPULATION WITHIN ANNULAR SECTORS BETWEEN
10-50 MILES

<u>Sector</u>	<u>10-20 Miles</u>	<u>20-30 Miles</u>	<u>30-40 Miles</u>	<u>40-50 Miles</u>	<u>Total</u>	<u>Sector</u>
N	69,330	35,961	143,546	60,073	308,910	N
NNE	133,838	237,191	354,551	544,621	1,270,201	NNE
NE	185,569	437,917	1,483,657	3,893,770	6,000,913	NE
ENE	119,874	166,477	1,134,648	1,629,062	3,050,061	ENE
E	33,077	112,389	69,706	0	215,172	E
ESE	29,247	35,408	111,280	0	175,935	ESE
SE	6,928	52,737	108,930	2,033	170,628	SE
SSE	5,004	4,984	7,887	11,023	28,896	SSE
S	5,933	61,238	7,349	3,935	78,455	S
SSW	52,983	55,122	56,229	114,782	279,116	SSW
SW	247,409	324,276	1,368,041	1,220,152	3,159,878	SW
WSW	35,985	117,952	310,930	289,105	753,972	WSW
W	12,576	20,180	69,806	56,145	158,707	W
WNW	6,054	10,112	15,399	254,563	286,128	WNW
NW	12,819	12,698	66,455	85,836	177,808	NW
NNW	14,429	14,462	34,875	14,937	78,703	NNW
TOTAL	971,055	1,699,104	5,343,289	8,180,037	16,193,485	TOTAL

*Taken from TFTR FSAR, Table 2.1.2-4

TABLE 7. POPULATION OF SMSA's WITHIN 50 MILES OF THE TFTR SITE
(S135b)

<u>SMSA's*</u>	<u>FSAR (1983) Census of April 1970</u>	<u>Estimate For July 1974</u>	<u>Census¹ of April 1980</u>
Allentown-Bethlehem Easton, PA (N.J. portion)	73,960	79,200	84,829
Jersey City, NJ	607,839	584,900	556,972
Long Branch Asbury Park, NJ	461,849	486,100	503,173
New Brunswick Perth Amboy Sayreville, NJ	583,813	549,900	595,893
New York, NY (NJ portion)	9,973,716	9,634,400	9,120,346
Newark, NJ	2,057,468	2,014,500	1,965,969
Paterson-Clifton- Passaic, NJ	460,782	456,700	447,585
Philadelphia, PA (NJ portion)	952,104	1,000,400	1,034,109
Trenton, NJ	<u>304,116</u>	<u>319,800</u>	<u>307,863</u>
TOTAL	15,475,647	15,125,900	14,616,739

*Standard Metropolitan Statistical Area

¹

Source: 1980 Census of Population and Housing ODEA

Table 8. Census and Population Projections for Counties
in New Jersey Within 10-50 Miles of TFTR Site
(St85b)

County	FSAR (1983)		Census ¹ of April 1980	Projections for July 1 ¹			
	Census of April 1970	Projection for 1985		1985	1990	1995	2000
Atlantic	175,770	202,760	194,119	206,700	220,000	233,400	245,800
Bergen	897,148	1,089,140	845,385	802,600	767,100	736,200	707,800
Burlington	323,132	413,600	362,542	391,200	422,300	454,800	487,000
Camden	456,291	553,030	471,650	482,900	497,400	512,700	526,400
Essex	932,326	985,530	851,304	813,700	785,400	761,600	739,900
Gloucester	172,681	217,980	199,917	216,400	233,600	250,600	265,700
Hudson	607,839	618,400	556,972	538,200	524,400	513,800	506,000
Hunterdon	69,718	94,220	87,361	94,600	101,300	107,700	113,200
Morris	383,454	449,110	407,630	412,800	418,200	422,700	423,900
Ocean	208,470	289,860	346,038	407,800	470,200	536,700	605,700
Passaic	460,782	545,980	447,585	440,500	434,800	428,700	421,200
Sussex	77,528	100,270	116,119	136,200	156,700	177,800	198,200
Union	543,116	642,210	504,094	482,400	467,800	458,800	454,200
Warren	73,960	83,590	84,429	90,300	96,300	102,200	107,400
Subtotal	5,292,215	6,285,680	5,475,145	5,516,300	5,595,500	5,697,700	5,802,400

(See Table 10 for Mercer, Middlesex, Somerset and Monmouth Counties.)

1. New Jersey Factbook, November 1984

State Data Center, New Jersey Department of Labor
Div. of Planning & Research, Office of Demographics & Analysis
CN, Trenton, New Jersey 08625-0388

Reference from: Princeton University Computer Center
(which is part of the network for the State Data Center)

TABLE 9. POPULATION OF COUNTIES IN NEW YORK AND PENNSYLVANIA
WITHIN 10-50 MILES OF THE TFTR SITE. (St85b)

NEW YORK¹

<u>County</u>	<u>*Census of April 1970</u>	<u>*Projection for 1985</u>	<u>Census of April 1980</u>	<u>Projection for 1990</u>
Kings	2,602,000	2,287,000	2,231,028	2,225,192
New York	1,539,000	1,309,000	1,428,285	1,452,080
Queens	1,987,000	1,909,000	1,881,325	1,914,038
Richmond	295,000	396,000	352,029	394,783
SUBTOTAL	6,423,000	5,901,000	5,892,667	5,986,093

PENNSYLVANIA²

<u>County</u>	<u>*Census of April 1970</u>	<u>*Projection for 1985</u>	<u>Census of April 1980</u>	<u>Projection for 1990</u>
Bucks	417,981	511,609	479,211	514,387
Chester	278,362	366,823	316,660	379,431
Delaware	602,741	645,373	555,007	506,311
Lehigh	255,679	293,715	272,349	271,602
Monroe	45,470	55,483	69,409	87,146
Montgomery	624,904	759,207	643,621	656,551
Northhampton	214,807	229,767	225,418	223,826
Philadelphia	1,927,673	1,952,912	1,688,210	1,595,393
SUBTOTAL	4,367,617	4,814,889	4,249,885	4,234,647
TOTAL	10,790,617	10,715,889	10,142,552	10,220,740

-
1. New York Department of Commerce April 1985
 2. Pennsylvania State Data Center April 1984

Table 10. Population Projections for Counties in New Jersey: 1985-2000
Within 0-10 Miles of TETR Site. (St85b)

County	Census Counts ¹		Projections for July 1 ¹			
	April 1970	April 1980	1985	1990	1995	2000
Mercer	304,116	307,863	307,100	306,300	304,700	301,900
Middlesex	583,813	595,893	598,400	601,200	603,000	603,300
Somerset	198,372	203,129	202,000	201,700	201,400	199,600
Monmouth	<u>461,849</u>	<u>503,173</u>	<u>525,100</u>	<u>546,400</u>	<u>566,000</u>	<u>580,800</u>
Subtotal	1,548,150	1,610,058	1,632,600	1,655,600	1,675,100	1,685,600

1. New Jersey Factbook, November 1984
State Data Center
New Jersey Department of Labor
Division of Planning & Research
Office of Demographics and Analysis
CN, Trenton, New Jersey 08625-0388

Note: These counties were not listed in FSAR

Table 11. Population of Municipalities Within 0-10 Miles of TFTR Site. (St85b)
(Mercer County)

Municipality	FSAR (1973)		Census ¹ of 1980	Projections ¹	
	Census of 1970	Projec- tion for 1985		1990	2000
MERCER COUNTY (TOTAL)	304,116	365,220	338,863	340,000	359,400
East Windsor Twp.	11,736	24,607	21,041	23,500	26,000
Hightstown (Boro)	5,431	6,624	4,581	5,000	5,100
Hamilton Twp.	79,609	97,024	81,801	87,700	90,000
Hopewell Twp.	10,030	16,008	10,893	11,025	13,650
Hopewell (Boro)	2,271	2,666	2,001	2,050	2,100
Pennington (Boro)	2,151	2,993	2,109	2,300	2,300
Lawrence Twp.	19,567	25,011	19,724	28,300	33,900
Princeton Twp.	13,651	18,009	13,683	14,400	14,700
Princeton (Boro)	12,311	14,000	12,035	12,600	12,700
Washington Twp.	3,311	5,003	3,487	8,500	8,800
West Windsor Twp.	<u>6,431</u>	<u>8,573</u>	<u>8,542</u>	<u>15,600</u>	<u>17,500</u>
Subtotal	166,499	220,518	179,897	210,975	226,750

1. "Mercer County Growth Management Plan,"
Mercer County Planning Board, 1985.

Table 12. Population of Municipalities Within 0-10 Miles of TFTR Site (St85b)
(Middlesex County)

Municipality	FSAR (1983)		*Census of 1980	Projections	
	Census Of 1970	Projec- tion for 1985		1990	2000
MIDDLESEX COUNTY (TOTAL)	583,813	730,160	595,893	*690,400	*757,100
Cranbury (Twp.)	2,253	2,629	1,927	**3,417	**4,632
East Brunswick (Twp.)	34,166	48,119	37,711	**52,960	**59,324
Helmetta (Boro)	955	1,222	955	**1,002	**1,031
Monroe (Twp.)	9,138	11,464	15,858	**16,413	**18,015
Jamesburg (Boro)	4,584	5,476	4,114	**5,298	**5,470
North Brunswick (Twp.)	16,691	22,040	41,442	**30,847	**30,847
Plainsboro (Twp.)	1,648	15,075	5,605	**14,046	**17,026
South Brunswick (Twp.)	14,058	18,546	17,127	**31,001	**43,004
Subtotal	83,493	124,571	124,739	154,984	179,349

*New Jersey Revised Total Age and Sex Population Projections, 1983

New Jersey Department of Labor
Office of Demographics and Economic Analysis
Division of Planning and Research
CN 388
Trenton, NJ 08625-0388
(Total Projections for Middlesex County Only)

**Municipal Forecasts by Middlesex County
Planning Board, August 1979

Table 13. Population of Municipalities Within 0-10 Miles of TETR Site. (St85b)
(Somerset County)

Municipality	FSAR (1983)		Census of 1980	Projections	
	Census of 1970	Projec- tion for 1985		1990	2000
SOMERSET COUNTY (TOTAL)	198,372	252,130	203,129	*246,800	*284,000
Franklin (Twp.)	30,389	40,270	31,358	**45,724	**52,651
Hillsborough (Twp.)	11,061	15,225	19,061	**26,665	**30,725
Montgomery (Twp.)	6,353	7,640	7,360	**11,099	**15,299
Rocky Hill (Boro)	<u>917</u>	<u>1,184</u>	<u>717</u>	<u>**717</u>	<u>**1,017</u>
Subtotal	48,720	64,319	58,496	84,205	99,692

*New Jersey Revised Total Age and Sex Population Projections, 1983
N.J. Department of Labor, Office of Demographics and Economic Analysis,
Division of Planning and Research
CN 388, Trenton, NJ 08625-0388

(Total projections for Somerset County Only)

**Municipal Projections by Somerset County Planning Board, 1984

Forrestal Campus, Princeton University

Monitoring Station Location: Bee Brook

[illegible]

Table 14 (cont's)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: B 1

Monitoring Station Location: Bee Brook

Parameters	7/18/85/	8/28/85	9/26/85 12:40PM	10/30/85 5:00 AM	11/20/85 4:55 PM	12/19/85 3:15 PM
Alkalinity, mg/l CaCO_3 , eq.	648	67	41	73	10	9
BOD mg/l O_2	3.8	4.7	5.0	2.0 2	1.4	<1
Calcium Hardness, mg/l CaCO_3 , eq	61	64	59	53	24	28
Chromium						
Total, mg/l Cr	<.02	0.08	<.02	<.02	<.02	<.02
Hexavalent, mg/l Cr	<.02	< 0.01	<.02	<.02	<.02	<.02
COD, mg/l O_2	27	27	29	5	13	20
Copper, mg/ l Cu	<.02	<.02	<.02	<.02	<.02	.02
Dissolved Oxygen, mg/l O_2	8.2	7.1	7.61	10.1	5.6	9.9
EDTA, mg/l Cu eq	.06	.04	0.5	.07	.07	1.1
Total coliform count, MPN/100 ml	43	2400	2400	2400	170	93
Flow, ft ³ /sec	0.002	0.01	.005	.25	.08	.16
Iron, mg/l Fe	.26	.31	.28	.48	.47	.07
Nitrogen						
Total Kjeldahl, mg/l N	4.0	<0.2	0.6	.28	.7	0.9
Nitrate, mg/l N	1.7	.74	0.7	.15	<.1	<.1
Oil & Grease, mg/l	<.5	<0.2	<0.2	<0.2	<0.2	<.5
pH	6.2	7.55	7.35	7.30	6.15	7.05
Phosphate						
Total, mg/l P	1.4	<.02	<0.2	<.02	<0.2	<.2
Ortho, mg/l P	0.3	<.02	<0.2	<.02	<0.2	<.2
Solids						
Dissolved, mg/l	203	233	152	134	108	110
Suspended, mg/l	5	<1.0	17	13	5	2.0
Sulfate, mg/l SO_4	37	46	17	9.1	16	22
Temperature, °C	23	23.5	18.5	10.5	16.0	0.0
Turbidity, NTU	2.7	3.2	27.0	3.4	1.8	2.9
Zinc, mg/l Zn	.02	.03	.03	0.03	0.03	0.02
Clarity	sl. cldy	clear	sl. cldy	sl. cldy	clear	clear

Forrestal Campus, Princeton University

Station: B 2

Monitoring Station Location: Bee Brook

[illegible]

Table 15 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: B 2

Monitoring Station Location: Bee Brook

Parameters	7/18/85	8/28/85	9/26/85 12:15 PM	10/20/85 4:20 PM	11/20/85 4:30 PM	12/19/85 1:50 PM
Alkalinity, mg/l CaCO_3 eq.	34	67.0	59.4	54	26	37
BOD, mg/l O_2	4.0	4.7	2.5	1.5	1.2	<1
Calcium Hardness, mg/l CaCO_3 eq.	42	54.0	86.0	54	52	76
Chromium						
Total, mg/l Cr	<.02	<.02	<.02	<.02	<.02	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02	<.02
COO, mg/l O_2	24	27	19	<2.0	<2.0	<2.0
Copper, mg/l Cu	.02	<.02	<.02	0.02	<.02	.03
Dissolved Oxygen, mg/l O_2	8.8	7.8	8.3	10.0	6.1	8.7
EDTA, mg/l Cu eq	.03	.03	.04	.06	.06	0.8
Total coliform count, MPN/100 ml	43	> 2400	> 2400	> 2400	240	93
Flow, ft ³ /sec	0.22	0.21	.23	.48	.37	.35
Iron, mg/l Fe	.43	.41	.43	.31	1.1	<.02
Nitrogen						
Total Kjeldahl, mg/l N	2.8	<0.2	0.8	.84	0.6	.04
Nitrate, mg/l N	1.2	.83	0.8	.40	0.1	<.1
Oil & Grease, mg/l	<.5	<0.2	2.7	<0.2	<0.2	<.5
pH	6.6	7.75	7.65	7.35	6.95	7.60
Phosphate						
Total, mg/l P	1.7	0.6	0.4	0.2	0.5	.3
Ortho, mg/l P	<0.2	0.3	0.4	<0.2	0.3	<.2
Solids						
Dissolved, mg/l	154	195	185	134	149	166
Suspended, mg/l	13	18	2.0	27	13	1.0
Sulfate, mg/l SO_4	33	27	21	13	15	22
Temperature, °C	26	25	21	12.5	17	6.5
Turbidity, NTU	13.0	8.0	5.0	3.0	7.2	5.0
Zinc, mg/l Zn	.06	.05	.05	.03	.03	0.03
Clarity	cloudy	clear	clear		sl cldy	clear

Table 16

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: C 1

Monitoring Station Location: Delaware Raritan Canal

<u>Parameters</u>	2/5/85	3/12/85	4/9/85	5/30/85	6/20/85	7/18/85
Alkalinity, mg/l CaCO_3 , eq	20	22	18	25	22	35
Calcium Hardness, mg/l CaCO_3 , eq	60	46	48	26	20	33
Chromium						
Total, mg/l Cr	0.02	0.03	0.02	<.02	.06	<.02
Hexavalent, mg/l Cr	<0.01	<0.01	<0.01	<.02	.03	<.02
Copper, mg/l Cu	<0.006	0.006	0.006	<.02	<.02	<.02
EDTA mg/l Cu eq.	<0.08	0.1	0.8	.06	.05	.05
Iron, mg/l Fe	1.4	2.9	1.8	.86	.86	.52
Nitrate, mg/l N	2.8	3.2	1.6	0.6	0.95	0.32
Oil & Grease, mg/l	< 1	< 1	< 1	.22	.44	1.3
pH	7.0	6.2	7.2	7.05	6.8	6.3
Phosphate						
Total, mg/l P	<0.01	0.31	0.17	0.46	3.3	1.4
Ortho, mg/l P	<0.01	0.18	0.09	0.05	0.13	<0.2
Solids						
Dissolved, mg/l	250	120	110	110	122	168
Suspended, mg/l	7	8	54	3	5	7.0
Sulfate, mg/l SO_4	24	19	21	22	31	20
Turbidity, NTU	5.5	2.4	5.5	6.5	.07	6.6
Zinc, mg/l Zn	<0.03	0.02	<0.02	.05	.01	.02
Clarity				sl. cldy	sl. cldy	sl. cldy

Table (16 cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: C 1

Monitoring Station Location: Delaware Raritan Canal

Parameters	8/28/85	9/26/85 10:15 AM	10/30/85 12:05 AM	11/20/85 4:45 PM	12/19/85 1:00 PM
Alkalinity, mg/l CaCO_3 eq	18	24	44	12	6
Calcium Hardness, mg/l CaCO_3 eq	22	44	50	68	56
Chromium					
Total, mg/l Cr	<.02	<.02	<.02	.03	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Copper, mg/l Cu	<.02	<.02	<.02	.03	<.02
EDTA mg/l Cu eq.	.03	.04	.06	.06	0.8
Iron, mg/l Fe	1.3	.72	1.9	3.2	.02
Nitrate, mg/l N	.58	0.1	0.048	0.19	<.1
Oil & Grease, mg/l	0.5	2.5	<0.2	<0.2	<.5
pH	6.4	6.85	8.4	6.35	7.3
Phosphate					
Total, mg/l P	0.3	<0.2	<0.2	0.3	<.2
Ortho, mg/l P	<0.2	<0.2	<0.2	<0.2	<.2
Solids					
Dissolved	115	125	127	158	145
Suspended, mg/l	23	14	32	97	1.0
Sulfate, mg/l SO_4	23	20	18	20	29
Turbidity, NTU	9.7	14.0	9.5	71	11
Zinc, mg/l Zn	.05	.05	.02	.08	<0.01
Clarity	sl. cldy	mod. cldy	mod. cldy	very cldy	sl. cldy

Table 17

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: D 1

Monitoring Station Location: Drainage Ditch

Parameters	2/5/85	2/19/85	3/12/85	3/26/85	4/9/85	4/23/85	5/30/85
Alkalinity, mg/l CaCO_3 , eq.	16	16	24	23	20	22	30
BOD mg/l O_2	<2	< 2	3	2	< 2	2	2.4
Calcium Hardness, mg/l CaCO_3 , eq.	62	46	102	48	50	73	32
Chromium							
Total, mg/l Cr	0.04	0.07	0.05	<0.01	0.02	< 0.02	<.02
Hexavalent, mg/l Cr	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	<.02
COD, mg/l O_2	33	42	23	< 5	5	8	16
Copper, mg/l Cu	0.01	0.3	0.01	0.02	0.01	0.02	<.02
Dissolved Oxygen, mg/l O_2	11	11	10	11	9.6	7.4	7.2
EDTA, mg/l Cu eq	0.1	0.59	0.2	0.7	0.7	0.8	.05
Total coliform count, MPN/100 ml	< 1	< 1	< 1	< 1	< 1	5	< 3
Flow, ft ³ /sec	1.5	1.6	1.3	4.4	1.4	1.2	.069
Iron, mg/l Fe	4.4	3.8	6.4	0.83	0.9	0.3	.67
Nitrogen							
Total Kjeldahl, mg/l N	<0.05	0.6	0.46	0.4	0.009	0.75	2.1
Nitrate, mg/l N	3.1	3.4	2.0	2.3	2.2	2.9	2.0
Oil & Grease, mg/l	< 1	< 2	< 1	< 1	< 1	3	<.2
pH	6.4	6.8	6.8	7.1	5.5	7.1	7.10
Phosphate							
Total, mg/l P	0.03	1.1	0.93	0.85	0.22	2.1	3.8
Ortho, mg/l P	0.01	0.04	0.37	<0.41	0.13	0.55	0.4
Solids							
Dissolved, mg/l	310	130	160	46	97	150	118
Suspended, mg/l	15	70	35	7	2	6	<1.0
Sulfate, mg/l SO_4	20	19	19	24	21	21	24
Temperature, °C	4.5	6	11	9	10	17	22
Turbidity, NTU	11	30	44	5.6	6.2	5.2	3.9
Zinc, mg/l Zn	<0.03	0.08	0.09	0.05	0.03	0.06	.03
Clarity							clear

Table 17 (cont'd)

WATER QUALITY MONITORING DATA
Forrestal Campus, Princeton University

Station: D 1

Monitoring Station Location: Drainage Ditch

Parameters	6/20/85	7/18/85	8/28/85	9/26/85 3:45 PM	10/30/85 3:40 PM	11/20/85 3:50 PM	12/19/85 2:30 PM
Alkalinity, mg/l CaCO_3 eq.	22	38	43.0	28	27	12	32
BOD ₅ , mg/l O_2	1.0	5.6	9.7	5.0	3.0	1.8	<1
Calcium Hardness, mg/l CaCO_3 eq.	23	35	30	52	40	68	56
Chromium:							
Total, mg/l Cr	.03	<.02	<.02	<.02	<.02	.03	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02	<.02	<.02
COD, mg/l O_2	15	25	36	27	26	< 2	<2.0
Copper, mg/l Cu	<.02	.02	<.02	<.02	<.02	.03	.03
Dissolved Oxygen, mg/l O_2	9.6	8.2	6.6	7.3	9.7	6.2	7.6
EDTA, mg/l Cu eq	.06	.05	.04	.04	.06	.05	0.8
Total coliform count, MPN/100 ml	23	23	43	> 2400	240	920	23
Flow, ft ³ /sec	0.17	0.06	0.07	.071	.076	.10	.09
Iron, mg/l Fe	.83	.41	0.8	.72	1.53	2.2	1.8
Nitrogen							
Total Kjeldahl, mg/l N	2.8	3.4	<0.2	<0.2	0.42	1.0	1.3
Nitrate, mg/l N	1.7	1.2	.55	0.7	0.78	0.42	<.1
Oil & Grease, mg/l	< .2	1.4	3.3	1.4	<0.2	<0.2	<.5
pH	6.85	6.8	6.85	7.05	7.25	6.60	7.00
Phosphate							
Total, mg/l P	3.2	2.0	0.9	0.7	0.7	0.9	.8
Ortho, mg/l P	0.5	0.5	0.5	0.5	<0.2	0.5	.4
Solids							
Dissolved, mg/l	137	222	139	139	135	160	105
Suspended, mg/l	4	69	2	2.0	13	34	<1.0
Sulfate, mg/l SO_4	31	31	24	23	23	15	25
Temperature, °C	24	25	27.0	22.3	17.0	16.0	10.3
Turbidity, NTU	.04	3.3	9.5	7.4	4.6	16	7.3
Zinc, mg/l Zn	.03	.03	.03	.03	.03	.03	.06
Clarity	clear	clear	sl cldy	sl cldy	mod cldy	very cldy	sl cldy

Forrestal Campus, Princeton University

Station: D 2

Monitoring Station Location: Drainage Ditch

[illegible]

Table 18 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: D 2

Monitoring Station Location: Drainage Ditch

Parameters	7/18/85	8/28/85	9/26/85 1:00 PM	10/30/85 5:35 PM	11/20/85 2:37 PM	12/19/85 4:00 PM
Alkalinity, mg/l CaCO_3 eq.	69	70.0	62.2	52	30	46
BOD, mg/l O_2	5.0	4.7	3.8	3.0	<1.0	<1.0
Calcium Hardness, mg/l CaCO_3 eq	58	53	90	54	72	96
Chromium						
Total, mg/l Cr	.02	<.02	<.02	<.02	.03	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02	<.02
COD, mg/l O_2	25	31	15	27	8.0	3.5
Copper, mg/l Cu	<.02	<.02	<.02	<.02	.03	<.02
Dissolved Oxygen, mg/l O_2	8.9	8.0	8.4	9.5	6.1	7.9
EDTA, mg/l Cu Eq	.06	.05	.04	.06	.06	0.8
Total Coliform count, MPN/100 ml	1100	> 2400	1100	> 2400	34	43
Flow, ft. ³ /sec	0.15	0.13	.18	.19	.37	.22
Iron, mg/l Fe	1.0	.47	.42	.79	1.9	<.02
Nitrogen						
Total Kjeldahl, mg/l N	3.2	2.3	<0.2	.77	0.8	1.0
Nitrate, mg/l N	1.1	.81	0.7	.68	.48	<.1
Oil & Grease, mg/l	2.1	<0.5	7.5	<.2	<.2	<.5
pH	7.1	7.65	7.70	7.55	7.10	7.60
Phosphate						
Total, mg/l P	1.5	0.6	0.5	0.4	0.6	.5
Ortho, mg/l P	0.4	0.3	0.4	<0.2	0.4	.4
Solids						
Dissolved, mg/l	205	205	89	159	146	143
Suspended, mg/l	32	7	<1.0	16	36	5.0
Sulfate, mg/l SO_4	28	27	21	24	11	25
Temperature, °C	26.5	25.5	21.0	16.0	17.5	9.5
Turbidity, NTU	13.0	9.8	5.0	3.1	18	96
Zinc, mg/l Zn	.03	.03	.03	.03	.03	<.01
Clarity	moderately cloudy	sl. cloudy	clear	sl. cloudy	sl. cloudy	sl. cloudy

Table 19

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: E-1

Monitoring Station Location: Elizabethtown Water

Parameters	2/5/85	3/12/85	4/9/85	5/30/85	6/20/85	7/18/85
Alkalinity, mg/l CaCO_3 , eq.	92	95	48	77	87	77
Calcium Hardness, mg/l CaCO_3 , eq.	100	110	58	70	73	84
Copper, mg/l Cu	0.009	0.01	0.008	<.02	.02	.02
Total coliform count, MPN/100 ml.	<1	<1	<1	<3	<3	<3
Iron, mg/l Fe	0.05	0.2	0.06	.07	.11	.21
Nitrogen						
Total mg/l N	<0.05	0.09	<0.05	2.2	1.5	3.5
Nitrate, mg/l NO_3	5.7	3.4	7	3.1	2.6	<.025
pH	7.2	7.2	6.2	7.05	6.95	6.9
Phosphate						
Total, mg/l P	<0.01	0.09	0.01	0.4	0.7	1.2
Ortho, mg/l P	<0.01	0.04	<0.01	0.03	0.08	<0.2
Manganese, mg/l Mn	<0.003	0.008	0.008	<.01	<.01	.01
Chloride, mg/l Cl	22	20	19	23	31	23
Solids						
Dissolved, mg/l	200	460	140	199	257	264
Sulfate, mg/l SO_4	18	22	13	50	52	74
Temperature, $^{\circ}\text{C}$	8	10	9	18.5	21	19.5
Turbidity, NTU	1.1	0.6	0.88	0.68	.16	1.2

Table 10 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: E-1

Monitoring Station Location: Elizabethtown Water

Parameters	8/28/85	9/25/85 2:30 PM	10/30/85 2:30 PM	11/20/85 3:10 PM	12/19/85 2:55 PM
Alkalinity, mg/l CaCO_3 eq.	49	90	96	80	58
Calcium Hardness, mg/l CaCO_3 eq.	66	113	102	140	108
Copper, mg/l Cu	<.02	<.02	<.02	.04	.03
Total coliform count, MPN/100 ml.	<3	<3	<3	<2	<3
Iron, mg/l Fe	.19	.13	.82	.47	.02
Nitrogen					
Total, mg/l N	<0.2	0.4	.49	2.9	.40
Nitrate, mg/l NO_3	1.9	1.8	.84	1.0	<.1
pH	6.85	6.85	7.05	7.10	7.40
Phosphate					
Total, mg/l P	<0.2	<0.2	<0.2	<0.2	<.2
Ortho, mg/l P	<0.2	<0.2	<0.2	<0.2	<.2
Manganese, mg/l Mn	.01	<.01	<.01	<0.01	185
Chloride, mg/l Cl	21	24	26	36	.17
Solids					
Dissolved, mg/l	233	198	222	236	22
Sulfate, mg/l SO_4	59	27	28	22	22
Temperature, $^{\circ}\text{C}$	24.0	19.5	15.0	15.0	9.0
Turbidity, NTU	2.0	1.4	0.40	0.36	34

Table 20

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: M 1

Monitoring Station Location: Millstone River

Parameters	2/5/85	3/12/85	4/9/85	5/30/85	6/20/85	7/18/85
Alkalinity, mg/l CaCO_3 , eq.	20	24	27	21	17	35
Calcium Hardness, mg/l CaCO_3 , eq.	56	48	48	26	18	32
Chromium						
Total, mg/l Cr	<0.05	0.07	0.02	<0.02	.04	<0.02
Hexavalent, mg/l Cr	<.01	<0.01	<0.01	<.02	<.02	<.02
Copper, mg/l Cu	<0.03	0.007	0.009	<.02	.02	<.02
EDTA mg/l Cu eq.	0.1	0.1	0.9	.12	.08	.07
Iron, mg/l Fe	19	0.6	1.6	1.22	1.19	.75
Nitrate, mg/l N	3.3	2.5	1.6	1.3	1.4	1.0
Oil and Grease, mg/l	<1	<1	<1	<.2	.9	4.5
pH	6.6	6.8	7.2	6.95	6.95	6.6
Phosphate						
Total, mg/l p	0.02	0.34	0.16	0.61	3.3	1.5
Ortho, mg/l p	<0.01	<0.21	0.1	0.21	0.21	<0.2
Solids						
Dissolved mg/l	220	220	110	114	134	178
Suspended, mg/l	390	6	6	4	5	25
Sulfate, mg/l SO_4	22	22	21	23	29	21
Turbidity, NTU	27	2.1	6.4	8.3	9.3	6.0
Zinc, mg/l Zn	0.1	0.03	<0.02	.04	.05	.06
Clarity				sl/cldy	sl/cldy	sl/cldy

Table 20 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: M 1

Monitoring station Location: Milestone River

<u>Parameters</u>	8/28/85	9/26/85 10:30AM	10/30/85 12:25 PM	11/20/85 4:30 PM	12/19/85 1:15 PM
Alkalinity, mg/l CaCO_3 eq.	13.0	24	20	19	14
Calcium Hardness, mg/l CaCO_3 eq.	22	47	47	76	56
Chromium					
Total, mg/l Cr	<.02	<.02	<.02	.03	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Copper, mg/l Cu	<.02	<.02	<.02	<.02	<.02
EDTA mg/l Fe	.05	.07	.08	.09	0.9
Iron, mg/l Fe	1.9	1.4	1.16	1.0	.03
Nitrate, mg/l N	1.0	1.9	0.78	0.45	<.1
Oil and Grease, mg/l	0.5	2.1	<0.2	<0.2	<.5
pH	6.45	6.85	7.05	6.55	7.15
Phosphate					
Total, mg/l p	0.35	<0.2	<0.2	0.2	<.2
Ortho, mg/l p	<0.2	<0.2	<0.2	<0.2	<.2
Solids					
Dissolved	154	166	129	124	144
Suspended, mg/l	21	6	12	12	5.0
Sulfate, mg/l SO_4	26	18	19	16	24
Turbidity, NTU	10.0	11.0	2.7	8.6	5.8
Zinc, mg/l Zn	.06	.05	.03	.04	0.01
Clarity	sl/cldy	sl/cldy	sl/cldy	clear	clear

Table 21

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: P 1

Monitoring Station Location: Off-site location

<u>Parameters</u>	2/5/85	3/12/85	4/9/85	5/30/85	6/20/85	7/18/85
Alkalinity, mg/l	18	24	16	36	22	27
Calcium Hardness, mg/l CaCO_3 , eq.	38	36	32	25	21	18
Chromium						
Total, mg/l Cr	0.04	0.05	<0.11	<.02	.03	<.02
Hexavalent, mg/l Cr	<0.01	<0.01	<0.01	<.02	<.02	<.02
Copper, mg/l Cu	0.006	0.004	0.001	<.02	.02	<.02
EDTA mg/l Cu eq.	<0.08	0.4	0.6	.06	.05	.06
Iron, mg/l Fe	7.4	0.05	0.5	2.1	1.6	2.5
Nitrate, mg/l N	3.5	2.3	1.9	0.23	.36	0.25
Oil & Grease, mg/l	<1	<1	<1	<.2	.22	3.3
pH	6.8	5.2	7.2	6.75	6.35	6.6
Phosphate						
Total, mg/l P	<0.01	0.04	0.11	0.48	5.4	1.4
Ortho, mg/l P	<0.01	0.01	0.04	0.05	0.12	<0.2
Solids						
Dissolved, mg/l	74	120	97	110	116	94
Suspended, mg/l	120	7	38	20	12	16
Sulfate, mg/l SO_4	8	10	13	21	23	9.5
Turbidity, NTU	21	5.3	12	7.9	4.0	7.8
Zinc, mg/l Zn	<0.03	<0.03	<0.2	.03	.03	.04
Clarity				sl. cldy	sl. cldy	sl. cldy

Table 21 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: P1

Monitoring Station Location: Off-site location

Parameters	8/28/85	9/26/85 11:10 AM	10/30/85 11:00 PM	11/20/85 3:25 PM	12/19/85 12:00 PM
Alkalinity, mg/l CaCO_3 eq.	15	22	27	18	6
Calcium Hardness, mg/l CaCO_3 eq.	16	37	35	48	56
Chromium					
Total, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Copper, mg/l Cu	<.02	<.02	.02	.02	.03
EDTA mg/l Cu eq.	.04	.05	.06	.06	0.9
Iron, mg/l Fe	1.7	1.8	2.2	1.2	1.4
Nitrate, mg/l N	.30	0.9	.23	.24	<.1
Oil & Grease, mg/l	3.8	7.0	<0.2	<0.2	<.5
pH	6.4	6.35	6.5	6.55	6.7
Phosphate					
Total, mg/l P	0.3	<0.2	<0.2	<0.2	<.2
Ortho, mg/l P	<0.2	<0.2	<0.2	<0.2	<.2
Solids					
Dissolved	100	100	107	117	112
Suspended, mg/l	18	<1.0	14	13	10
Sulfate, mg/l SO_4	14	3.5	15	23	26
Turbidity, NTU	9.8	8.3	4.6	10	4.5
Zinc, mg/l Zn	.03	.03	.03	.02	0.09
Clarity	sl. cldy	sl. cldy	sl. cldy	sl. cldy	clear

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Table 22

WATER QUALITY MONITORING DATA
Forrestal Campus, Princeton University

Station: P2

Monitoring Station Location: Off site location

Parameters	2/5/85	3/12/85	4/9/85	5/30/85	6/20/85	7/18/85
Alkalinity, mg/l CaCO_3 , eq.	10	12	12	19	11	23
Calcium Hardness, mg/l CaCO_3 , eq.	56	44	44	19	13	23
Chromium						
Total, mg/l Cr	0.04	0.01	<0.01	<.02	.04	.02
Hexavalent, mg/l Cr	<0.01	<0.01	<0.01	<.02	.02	<.02
Copper, mg/l Cu	0.03	0.003	0.007	<.02	<.02	<.02
EDTA mg/l Cu eq.	<0.08	0.8	0.6	.04	.03	.05
Iron, mg/l Fe	6	0.3	1.2	.72	.78	.39
Nitrate, mg/l N	3.2	1.7	0.97	3.6	1.0	1.2
Oil & Grease, mg/l	<1	<1	<1	.32	.64	2.7
pH	6.4	6.0	7.4	7.10	6.55	6.6
Phosphate						
Total, mg/l P	<0.01	0.09	0.13	0.47	0.8	1.2
Ortho, mg/l P	<0.01	0.03	0.04	<0.01	0.06	<0.2
Solids						
Dissolved, mg/l	220	130	76	108	104	166
Suspended, mg/l	26	7	8	1.0	<1.0	3
Sulfate, mg/l SO_4	26	19	23	7.6	7.0	13
Turbidity, NTU	15	3.4	6.9	5.4	3.3	3.1
Zinc, mg/l Zn	0.03	0.03	<0.02	.04	.03	.02
Clarity				sl. cldy cldy	sl. cldy cldy	clear

Table 22 (cont'd)

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: P2

Monitoring Station Location: Off site location

Parameters	8/28/85	9/26/85 11:30 AM	10/30/85 11:35 AM	11/20/85 3:45 PM	12/19/85 10:30 AM
Alkalinity, mg/l CaCO_3 eq.	7.5	26	20	16	8
Calcium Hardness, mg/l CaCO_3 eq.	14	46	29	40	36
Chromium					
Total, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Hexavalent, mg/l Cr	<.02	<.02	<.02	<.02	<.02
Copper, mg/l Cu	<.02	<.02	<.02	.02	<.02
EDTA mg/l Ca eq.	.04	.04	.05	.04	0.8
Iron, mg/l Fe	1.4	.68	.37	1.1	.02
Nitrate, mg/l N	.72	2.2	1.1	0.24	<.1
Oil & Grease, mg/l	1.9	3.8	<0.2	<0.2	<.5
pH	6.15	6.90	6.60	5.95	6.8
Phosphate					
Total, mg/l P	0.2	<0.2	<0.2	<0.2	<.2
Ortho, mg/l P	<0.2	<0.2	<0.2	<0.2	<.2
Solids					
Dissolved	140	116	98	102	95
Suspended, mg/l	25	6.0	13	17	15
Sulfate, mg/l SO_4	21	2.7	7.2	9	17
Turbidity, NTU	23.0	3.6	3.1	95	16
Zinc, mg/l Zn	.05	.05	.03	.03	.01
Clarity	mod. cldy	sl. cldy	clear	mod. cldy	sl. cldy

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Table 23

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: W 4

Monitoring Station Location: Underground Well

Parameters	5/31/85	6/20/85	9/26/85 2:00 PM	12/19/85 4:25 PM
Alkalinity, mg/l CaCO_3 eq.	*	112	106	70
Calcium Hardness, mg/l CaCO_3 eq		48	92	84
Copper, mg/l Cu		.12	.03	.07
Total coliform count, MPN/100 mg.		93	23	240
Iron, mg/l Fe		21	3.9	14
Nitrogen				
Total mg/l N		2.4	1.3	.70
Nitrate, mg/l NO_3		<.025	0.1	.36
pH		7.35	7.55	7.45
Phosphate				
Total, mg/ P		5.2	0.4	.9
Ortho, mg/l P		0.73	0.4	.6
Manganese, mg/l Mn		.37	.30	.52
Chloride, mg/l Cl		41	146	6
Solids				
Dissolved, mg/l		203	181	142
Sulfate, mg/l SO_4		26	13	12
Temperature, °C		15.0	18.0	9.2
Turbidity, NTU		75	27.0	74

*broken pipe - no sample available

Table 24

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Station: W 5

Monitoring Station Location: Underground Well

<u>Parameters</u>	5/31/85	8/25/85	11/21/85 10:20 AM
Alkalinity, mg/l CaCO_3 eq.	79	47	40
Calcium Hardness, mg/l CaCO_3 eq	72	42	76
Copper, mg/l Cu	<.02	.03	<.02
Total coliform count, MPN/100 mg.	<3	43	21
Iron, mg/l Fe	1.9	.95	0.93
Nitrogen.			
Total mg/l N	1.7	<0.2	0.3
Nitrate, mg/l NO_3	3.6	.81	0.24
pH	6.95	6.45	6.10
Phosphate			
Total, mg/ P	0.4	0.4	<.02
Ortho, mg/l P	<0.01	0.2	<0.2
Manganese, mg/l Mn	<.01	.20	.13
Chloride, mg/l Cl	23	55	11
Solids			
Dissolved, mg/l	194	130	122
Sulfate, mg/l SO_4	44	18	15
Temperature, °C	18.0	14.0	14.0
Turbidity, NTU	1.0	9.9	2.6

TABLE 25

FERTILIZER, PESTICIDES AND HERBICIDES APPLICATION (C186)FERTILIZER

(Applied by University)

10-6-4 50% Organic

A Site	1000 lbs.
B Site	1800 lbs.
C Site	1200 lbs.
D Site	1000 lbs.

PESTICIDES

(Applied by University)

A Site	No pesticides applied
B Site	No pesticides applied
C Site	No pesticides applied
D Site	No pesticides applied

HERBICIDES

<u>DATE</u>	<u>LOCATION</u>	<u>PRODUCT</u>	<u>AMOUNT</u>
4/16/85	Softball field	Pendimethain	356 lbs.
5/13/85	Softball field	Trimec	2 gals. in 200 gal. water
6/1/85	C & D Sites	Princep Caliber 98 Roundup	40 lbs. 1 gal.
6/3/85	Canal Pump House Yard	Hyvar XL	2 gals. in 50 gal. water
6/4/85	TFTR Electrical Yards	Pramitol 25EC	15 gals. in 300 gal. water
6/6/85	TFTR Electrical Yards	Pramitol 25EC	20 gals. in 400 gal. water
7/12/85	1H Bldg Courtyard	Amitrol 25E	2.5 oz. in 1 gal. water
7/29/85	Receiving Yard	Pramitol 25EC	10 gals. in 100 gal. water
8/13/85	C Site	Trimec	1 gal.

TABLE 25 (cont'd)HERBICIDES

<u>DATE</u>	<u>LOCATION</u>	<u>PRODUCT</u>	<u>AMOUNT</u>
8/15/85	C & D Sites	Princep Calber 90 Roundup	40 lbs. 1 gal.
8/19/85	Receiving Yard under water tower	Roundup S Ammate 2e	.5 gal. .5 gal. in 50 gal. water
9/3/85	CAS Bldg. (rear)	Roundup S	.5 gal. in 50 gal. water

Table 26

WATER QUALITY MONITORING DATA

Forrestal Campus, Princeton University

Report of Analysis

12/19/85

12:30 PM

<u>Parameters</u>	QA 117-B	QA 119-A
	mg/l	
Alkalinity, CaCO_3 eq.	52	50
$\text{BOD}_5 \text{ O}_2$	<1	<1
Calcium hardness, CaCO_3 eq.	108	104
Chromium		
Total, Cr	<.02	<.02
Hexavalent, Cr.	< .02	<.02
COD, O_2	<2.0	<2.0
Copper	.05	.02
Dissolved Oxygen, O_2	7.9	7.9
EDTA, Cu eq	0.9	0.5
Total coliform count, MPN/100ml	240	460
Iron	.20	3.3
Nitrogen		
Total Kjeldahl, mg/l N	.90	1.6
Nitrate, mg/l N	<.1	<.1
Oil & grease	<.5	<.5
pH	7.50	7.65
Phosphate		
Total, mg/l P	.5	.5
Ortho, mg/l P	.3	.3
Total dissolved solids	140	158
Total dissolved solids	12	8.0
Sulfate	24	25
Turbidity	1.7	4.5
Zinc	.27	.08
Clarity	clear	clear

TABLE 27
QA/QC EPA/LAS VEGAS CROSS-CHECK PROGRAM 1985

<u>SAMPLE DATE</u>	<u>TYPE SAMPLE</u>	<u>KNOWN VALUES HTO CONCENTRATION (pCi/L) PLUS EXPECTED LAB PRECISION</u>		<u>PPPL VALUES (pCi/L)</u>
2/2/85	Water	3796 $\pm$ 634		4240
				4230
				4250
4/12/85	Water	3999 $\pm$ 630		3580
				3660
				3550
4/26/85	Urine	3056 $\pm$ 622		3160
				3250
				3240
8/16/85	Water	4480 $\pm$ 448		4370
				4370
				4260
10/11/85	Water	1974 $\pm$ 345		1920
				1950
				1970
11/8/85	Urine	3586 $\pm$ 365		3790
				3790
				3650

FIG. 1
S-1 SPHERONAK

FIG. 2
RTF

FIG. 3
PRINCETON LARGE TORUS (PLT)

FIG. 4
PRINCETON BETA EXPERIMENT (PBX)

FIG. 5
TOKAMAK FUSION TEST REACTOR (TFTR)

FIG. 6

Wind Rose
 Joint Frequency Data for TFTR
 84/ 1 to 85/12
 Elevation 30 m
 For All Stability Classes (100.0%)

Wind Speed (m/s)

10.0	and above
7.0	to 10.0
5.0	to 7.0
3.0	to 5.0
2.0	to 3.0
1.5	to 2.0
1.0	to 1.5
0.75	to 1.0
0.22	to 0.75

Center = Calm %

FIG. 7

Wind Rose
 Joint Frequency Data for TFTR
 84/ 1 to 85/12
 Elevation 60 m
 For All Stability Classes (100.0%)

Wind Speed (m/s)

10.0	and above
7.0	to 10.0
5.0	to 7.0
3.0	to 5.0
2.0	to 3.0
1.5	to 2.0
1.0	to 1.5
0.75	to 1.0
0.22	to 0.75

Center = Calm %

FIG. 8
30-Km (50-MILE) RADIUS OF SITE

FIG. 9
IMMEDIATE SITE VICINITY
(5-MILE RADIUS)

83A0021

FIG. 10
 PLASMA PHYSICS LABORATORY
 JAMES FORRESTAL CAMPUS
 PRINCETON UNIVERSITY, PRINCETON, NJ

FIG. 11
1974 POPULATION ESTIMATES WITHIN ANNULAR SECTORS 0-10 MILES*

*Taken from TFTR/FSAR
FIGURES 2.1.2-1

FIG. 12
1985 POPULATION ESTIMATES WITHIN ANNUAL SECTION 0-10 MILES*

*Taken from TFTR/FSAR
Figure 2.1.2-3

1. Auditorium
2. Offices
3. TFTR Control
4. Technical Shop
5. TFTR Experimental Area
6. Motor Generator
7. Maintenance & Utility
8. Pump House
9. Cooling Tower
10. New Parking
11. Detention Pond
12. Switchyard Expansion
13. Radioactive Waste
14. Field Coil P.C. Building
15. Neutral Beam P.C. Building
16. Gas Tank Farm Area

FIG. 13

PPPL C AND D SITES AND ENVIRONMENTAL MONITORING LOCATIONS

EZB	Exclusion Zone Boundary
RMS-B	Fence
RMS-1	Baseline Radiation Monitoring Station & Old Meteorological Tower
RMS-2	Radiation Monitoring Station
RMS-3	"
RMS-4	"
D-1	Ditch 5 Surface Water Sample Location
D-2	Ditch 5 Surface Water Sample Location
B-1	Bee Brook Surface Water Sample Location
B-2	Bee Brook Surface Water Sample Location
MET	New Meteorological Tower
E-1	Elizabethtown Sample Location
W-4	Well #4
W-5	Well #5

FIG. 14
MILLSTONE RIVER BASIN OFFSITE WATER SAMPLE LOCATION

FIG. 15
PLANNED OFF-SITE MONITORING LOCATIONS

FIG. 16
 CY84-85 NEUTRON AND GAMMA ENVIRONMENTAL BACKGROUND DATA
 (LOCATION'S RMS-B)

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