

1 of 1

PANTEX PLANT CELL 12-44-1 TRITIUM
RELEASE: RE-ASSESSMENT OF
ENVIRONMENTAL DOSES FOR 1990 TO 1992

S. F. Snyder
S. T. Hwang

March 1994

Prepared for Battelle Pantex
and Mason and Hanger-Silas Mason Co., Inc.
Amarillo, Texas
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

MASTER

REPRODUCTION OF THIS DOCUMENT IS UNRESTRICTED *yp*

SUMMARY

A release of tritium gas occurred within Cell 12-44-1 at the Pantex Plant on May 17, 1989. The release was the result of a nuclear component containment failure. This document summarizes past assessments and characterization of the release. From 1990 to 1992, the average annual dose to the offsite maximally exposed individual (MEI), re-assessed using updated methods and data, ranged from $9E-6$ to $2E-4$ mrem/y. Doses at this level are well below the regulatory dose limit and support the discontinuation of the distinct calculation of the MEI doses from the cell's tritium releases in future Pantex Annual Site Environmental Reports.

Additional information provides guidance for the evaluation of similar releases in the future. Improved Environmental Protection Department sampling plans and assessment goals will increase the value of the data collected during future incidents.

ACRONYMS

| | |
|--------|---|
| ALARA | as low as reasonably achievable |
| ASER | <i>Annual Site Environmental Report</i> |
| DCF | dose conversion factor |
| EM | environmental monitoring |
| EPD | Environmental Protection Department |
| HE | high explosive |
| MEI | maximally exposed individual |
| NESHAP | "National Emission Standards for Hazardous Air Pollutants" (40 CFR 61) |

CONTENTS

| | |
|---|------|
| SUMMARY | iii |
| ACRONYMS | v |
| 1.0 INTRODUCTION | 1.1 |
| 2.0 BACKGROUND INFORMATION | 2.1 |
| 2.1 ENVIRONMENTAL TRANSPORT OF TRITIUM | 2.1 |
| 2.2 INCIDENT SUMMARY | 2.3 |
| 2.3 PAST EVALUATIONS AND MONITORING | 2.5 |
| 2.3.1 Offsite Dose Calculations | 2.5 |
| 2.3.2 1990 Cell 12-44-1 Characterization | 2.6 |
| 2.3.3 Environmental Measurements | 2.7 |
| 3.0 ASSESSMENT OF TRITIUM RELEASE | 3.1 |
| 3.1 TRITIUM RELEASE RATE ESTIMATION | 3.2 |
| 3.2 TRITIUM CONCENTRATIONS IN AIR AT THE MEI LOCATION | 3.5 |
| 3.3 CALIBRATION OF MODEL ESTIMATES | 3.10 |
| 3.4 DOSE ASSESSMENT CONCLUSIONS | 3.11 |
| 4.0 ENVIRONMENTAL MONITORING | 4.1 |
| 4.1 USE OF PAST ENVIRONMENTAL MEASUREMENTS | 4.2 |
| 4.1.1 Air Monitoring | 4.2 |
| 4.1.2 Soil and Vegetation Monitoring | 4.3 |
| 4.2 ENVIRONMENTAL MONITORING CONCLUSIONS | 4.3 |
| 5.0 REFERENCES | 5.1 |
| APPENDIX A - SOIL AND VEGETATION MONITORING RESULTS | |
| APPENDIX B - GENII BASE-CASE OUTPUT FILE . | |

FIGURES

| | | |
|-----|---|-----|
| 2.1 | Tritium Measurements from Air Monitoring Station PA-06, 1989 to 1992 | 2.9 |
| 3.1 | Tritium Gas Release Rate vs. Porosity of Gunite at Different Ceiling Air Concentrations | 3.6 |
| 3.2 | Tritium Oxide Release Rate vs. Porosity of Gunite at Different Ceiling Air Concentrations | 3.7 |
| A.1 | Soil and Vegetation Monitoring Locations | A.5 |

TABLES

| | | |
|-----|---|------|
| 2.1 | Tritium Measured at Air Monitoring Station PA-06, 1989 to 1992 | 2.10 |
| 3.1 | Assumed Thickness and Porosity of Dome Layers | 3.4 |
| 3.2 | Annual Average Atmospheric Dispersion Values ($\bar{\chi}/Q'$ Values), 1990 to 1992, by Direction of Release | 3.8 |
| 3.3 | Comparison of the Model and Actual Measurements of Median Tritium Concentrations at Station PA-06, 1990 to 1992 | 3.10 |

1.0 INTRODUCTION

During a routine weapon disassembly operation at the Pantex Plant, May 17, 1989, a release of tritium gas occurred inside Cell 1 of Building 44, Zone 12 South (hereafter, Cell 12-44-1), beginning at approximately 2:30 p.m. The estimated tritium activity originally in the disassembled component was 40,000 Ci. As soon as an alarming, wall-mounted tritium monitor detected elevated airborne tritium levels in Cell 12-44-1, plant workers exited the room. Incident response was initiated immediately. All of the tritium in the component was believed to have been released within 24 hours of the start of the release. Except for the immediate incident response and subsequent infrequent radiation monitoring of Cell 12-44-1, the Cell has remained inactive.

Environmental monitoring of the soil- and vegetation-moisture in the region about Cell 12-44-1 in the 3 years since the incident has indicated the continued presence of tritium in these media. An air monitoring station 100 m south of Cell 12-44-1 continues to detect elevated levels of tritium. These measurements indicate that tritium from Cell 12-44-1 continues to enter the above-ground environment from its below-ground release site. The tritium entering the environment can travel offsite, resulting in potential exposures to offsite individuals.

This report focuses on the long-term (i.e., 3-plus years following the release) environmental protection and monitoring aspects of the accidental release. The Pantex Emergency Preparedness staff, of the Environmental, Safety, and Health Division, had responsibilities for addressing the short-term and immediate response actions for this incident. However, the Environmental Protection Department (EPD) took over responsibility for the long-term follow-up of the environmental and public health aspects of the residual tritium releases. The long-term follow-up was performed during a period of significant EPD organizational and personnel transitions. Formal follow-up plans were not established by the EPD. The Radiation Safety Department has responsibility for worker safety adjacent to Cell 12-44-1 and for decontamination and decommissioning of the cell.

This report includes an assessment of the dose to the maximally exposed individual (MEI) in the offsite region for all past calendar years since the incident, except for 1989, the year of occurrence. Also, general recommendations for long-term air, soil, and vegetation monitoring of tritium releases are provided. This document serves to:

- summarize past EPD activities related to the Cell 12-44-1 release,
- re-assess offsite doses, and
- provide guidance for future response to similar incidents.

The dose assessment presented in this report is a re-evaluation of post-1989 MEI doses using more realistic assumptions, additional data, and different computer codes than past assessments had used. Past assessments used more conservative and readily available information. The environmental monitoring recommendations presented in Section 4.0 were designed to permit better trending of the release and will be helpful in planning monitoring schedules in the event of a similar incident in the future.

2.0 BACKGROUND INFORMATION

Information regarding the incident and incident-related monitoring activities are detailed in this section. Additional background information relative to tritium transport in the environment is provided at the outset to familiarize the reader with considerations pertaining to the environmental pathways modeling of tritium releases.

2.1 ENVIRONMENTAL TRANSPORT OF TRITIUM

Tritium is a radioisotope of hydrogen with a half-life of 12.3 years. Hydrogen is a ubiquitous element in the biologic environment. This contrasts with other elements that are present in biota in much smaller concentrations or at discrete locations. The hydrogen requirement of biota is much greater than the requirements for other elements. Due to the abundant distribution of hydrogen in the environment and its high concentration in biota, environmental transport codes typically model the cycling of tritium differently than other radionuclides (with the exception of carbon-14, a radioisotope of another pervasive element).

The environmental modeling of tritium usually follows the form of a specific-activity equivalence model. Specific activity is defined as the concentration of a radioisotope in a given material (Cember 1987); i.e., the ratio of radioactive hydrogen (tritium) to non-radioactive hydrogen is assumed to be equivalent in both the contaminating medium and the exposed medium. This assumption is rather accurate for situations of chronic (continuous) exposure to tritium (Kennedy and Strenge 1992). Relating this model to the Cell 12-44-1 release, the specific activity of the tritium in the air at the location of the MEI is used to estimate the specific activity of tritium in other media (e.g., food crops and soil); the other media, in addition to the tritium in the air, contribute to the MEI dose.

One complicating factor in the evaluation of tritium releases concerns the chemical form of the tritium. When tritium gas (HT or T_2) is released to the environment, it can be oxidized into tritium oxide (HTO , T_2O , or "tritiated water"). The biologic absorption of tritium oxide intakes are

much greater than that of tritium gas. This is illustrated by the different inhalation dose conversion factors (DCFs) for each chemical form (DOE 1988):

| <u>Chemical Form</u> | <u>DCF</u> |
|----------------------|---|
| Tritium gas (HT) | Lung 4.4E-9 rem/h per $\mu\text{Ci}/\text{m}^3$ |
| | CEDE 9.2E-9 rem/h per $\mu\text{Ci}/\text{m}^3$ (a) |
| Tritium oxide (HTO) | Lung 6.3E-5 rem/ μCi inhaled |
| | CEDE 6.3E-5 rem/ μCi inhaled |

Although models have been developed to account for the above-ground (i.e., atmospheric) transport of tritium, much less is known about its transport through soil to the atmosphere in situations of underground releases. Experimental findings relevant to the below-ground transport of tritium are summarized in the following paragraph.

Jacobs et al. (1979) described the great efficiency with which soil microbes can convert HT to HTO, using the enzyme hydrogenase. The rate at which this occurs is significantly faster than the natural conversion rate in the atmosphere. Garland (1979) reported the results of soil tritium concentrations at various soil depths after atmospheric deposition onto bare and grass-covered soil. Although this release scenario does not parallel the Cell 12-44-1 incident, several findings can be applied to the assessment of this incident. Garland (1979) found that the tritium concentrations in the upper soil layer decreased rapidly once source term deposition ceased. In addition, it was reported that rain caused HTO to displace downwards and diffuse to a greater depth than that occurring in rain-sheltered soil. The presence of grass at the soil surface caused soil tritium measurements to vary over a greater range, primarily attributed to the scattered presence of the grass roots. In addition, the HTO was retained in the grass-covered soil longer than in bare soil.

(a) This EDE is calculated according to the methodology of Peterman et al. (1985) and Hill and Johnson (1993). The methodology upon which DOE (1988) was based does not include the dose contribution from HT metabolized to HTO.

2.2 INCIDENT SUMMARY

Several "cells" have been constructed at the Pantex Plant for the purposes of minimizing the consequences of an accidental high explosives (HE) detonation during nuclear-device handling (see Figure A.1). The Cell 12-44-1 complex essentially consists of a tunnel area leading to a "round room." The entire complex, except for the dome above the round room, is located below ground level. The maze-like tunnel area leading to the round room contains personnel and equipment interlock doors, which are located approximately halfway down the tunnel area. The tritium release occurred in the round room (34 ft in diameter) of the Cell 12-44-1 complex.

The round room is constructed of a concrete slab floor covered with epoxy and linoleum; the walls are painted concrete. A painted, drywall ceiling in the round room conceals the gravel dome that was constructed to absorb shocks from an accidental HE detonation. Two gravel pockets were constructed in different locations of the Cell 12-44-1 tunnel for the same purpose.

Donham et al. (1989) describes the construction of the Cell 12-44-1 dome:

Cables and wire screen support the gravel dome. The dome is constructed of 18-inch layer of 1- to 2-inch gravel covered by a screen and a layer of 10-mesh to 2-inch graded gravel to a total thickness of 20 ft. The gravel was compacted over a suspended catenary grid of 1.5-in. bridge strand cable and four layers of wire mesh. The edge of the gravel tapers to overlap the earth mound outside the wall. The gravel over the cell is capped with 3 in of Gunitite [i.e., concrete] that sandwiches a layer of saturated asphalt cotton seal and is further protected from erosion by asphalt strip cover [i.e., "Gulf seal"].

When tritium was accidentally released into the round room of Cell 12-44-1 during testing of component valves, tritium leaks were detected by a wall-mounted tritium monitor located in the round room. When the monitor alarmed on the day of the incident, the personnel immediately left the cell and exited through the interlocked doors. The alarm network notified Pantex Plant radiation technicians of the incident and incident response began immediately.

The valve through which the tritium ultimately entered the round room was left open when the incident occurred. Thereby, essentially all the tritium activity was released from the component into the round room. This was indicated by the increasing tritium measurements in the Cell 12-44-1 tunnel air outside the interlocked doors. At approximately 4 p.m. on the day of the accident, a decision was made to vent the release through large doors in a warehouse, Building 12-42, connected to the Cell 12-44-1 tunnel ramp (see Figure A.1). This venting would disperse the tritium directly to the outdoor environment and prevent its build-up in the tunnel and connected buildings. Portable ventilation equipment was used during the second day after the release to vacuum air from the equipment interlock area to the warehouse doors. This ventilation equipment served to ventilate the tunnel but is not believed to have resulted in much air exchange within the round room.^(a) The amount of tritium moved by the ventilation equipment is not known.

A meteorological event that occurred shortly after the tritium was released into the cell has important implications for dose to offsite individuals exposed to the tritium releases in 1989. At that time, a thunderstorm occurred after a regional dry spell. During the few hours following the release, approximately 0.5 in. of rain fell and the wind direction shifted drastically; an additional 6.6 in. of rain fell over the next 6-week period. The wind direction shifts of this event served to widely disperse any tritium gas releases, significantly decreasing the dose to the offsite MEI.

Tritium releases to the atmosphere and ground-level environment resulting from the Cell 12-44-1 incident occurred and have continued to occur via several sources:

- **during initial hours of the accident** - the acute ventilation of the airborne tritium through the warehouse doors via portable ventilation equipment
- **initial hours to days** - the above-ground deposition of condensation dispersed with tritium from the Cell 12-44-1 dehumidifier which was inadvertently operational for a short period and use of portable ventilation equipment to increase ventilation rate

(a) Personal communication, R. Burke, Emergency Management Department Manager, Pantex Plant, Amarillo, Texas, August 19, 1993.

- **approximately June 1989 to present** - chronic tritium releases from activity diffusing from the Cell 12-44-1 gravel dome and soil immediately surrounding the cell to the ground-level environment
- **cell characterization** - a special study, requiring entry into Cell 12-44-1, was conducted to characterize the extent of the tritium contamination (see Section 2.3.2). Cell entry and sampling resulted in the release of some of the tritium from the cell.

In this report, doses to individuals in the vicinity of the Pantex Plant are assessed by estimating the activity released and previous dose assessments and monitoring in the vicinity of Cell 12-44-1 are reviewed. Due to the lack of knowledge regarding the quantity of acutely released activity in the first year of the accident, the 1989 doses were not re-evaluated. It is assumed that the Emergency Preparedness Staff adequately addressed the public health concerns in the initial year of the accident. The annual average dose to the MEI from 1990 to 1992 are re-assessed in Section 3.0. The expected MEI dose for the years following 1992 are also suggested.

2.3 PAST EVALUATIONS AND MONITORING

There have been three types of prior evaluations of Cell 12-44-1 and its releases. The purpose of the first type was to calculate offsite doses to the MEI, as required by both DOE 5400.1 (DOE 1990) for *Annual Site Environmental Reports* (ASERs) and by the U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (40 CFR 61) reports. The purpose of the second type of evaluation was to characterize the contamination of the cell to plan for radiation protection measures to keep exposures as low as reasonably possible (ALARA) during decontamination activities. The purpose of the third type of measurements was to implement routine air monitoring and conduct special-purpose soil and vegetation sampling in the vicinity of Cell 12-44-1.

2.3.1 Offsite Dose Calculations

The ASER requirements and NESHAP regulations require that a dose assessment be performed for all airborne radioactive releases from the Pantex Site. An ASER assessment of doses for 1989 and 1990 includes estimates of tritium contributions from the releases of Cell 12-44-1. The ASER dose assessments for 1991 and 1992 assume negligible releases from Cell 12-44-1.

AIRDOS-EPA, an early version of the CAP88-PC code (Parks 1992), had been used to estimate these doses. AIRDOS-EPA is a code that conservatively approximates doses from atmospheric releases at the location of the MEI. This code was designed to estimate the dose to the MEI from chronic releases of radionuclides. The MEI location for the Cell 12-44-1 releases was determined to be the boundary location 1900-m ESE of the cell (M&H 1990).

The annual effective dose equivalent to this MEI as reported in the Pantex Plant ASERs are as follows:

| <u>Year of exposure</u> | <u>MEI dose (mrem)Reference</u> |
|-------------------------|---------------------------------|
| 1989 | 1.43 M&H 1990 |
| 1990 | 0.16 M&H 1991 |
| 1991 | 1E-5 BP and M&H 1992 |
| 1992 | 9E-6 BP and M&H 1993 |

The 1989 dose estimate of 1.43 mrem (M&H 1990) assumed the entire 40,000 Ci of tritium gas was uniformly released over the year. The 1990 dose was calculated under the assumption that 2550 Ci of tritium were released over the year (M&H 1991). The 2550 Ci was the estimated inventory of trapped tritium from a characterization of Cell 12-44-1 conducted in early 1990 (see Section 2.3.2). The 1991 and 1992 source terms were estimated to be 0.17 Ci (BP and M&H 1992) and 0.126 Ci (BP and M&H 1993), respectively, when no major tritium gas releases from the Cell 12-44-1 region were considered.

2.3.2 1990 Cell 12-44-1 Characterization

A characterization of Cell 12-44-1 was conducted by AWC Nuclear Services in January and February of 1990 (AWC 1990). The characterization was conducted to ascertain the amounts and locations of the tritium remaining in and around the cell. Only relevant results of this characterization study will be reviewed in detail in this report.

The interior surfaces and certain Cell 12-44-1 construction materials were sampled to determine the level of remaining tritium contamination. Tritium was found on all round room surfaces with the highest levels found on the floor. The ceiling showed the lowest activities of all the room's

structural surfaces. [This suggests that condensation within the round room occurs more readily on the floor than on the walls or ceiling.] The round room walls are painted concrete and the concrete floor is covered with epoxy and linoleum. Tritium was found to have penetrated all concrete structures. Tritium levels in the round room air were found to be inversely related to the outdoor barometric pressure (i.e., as the atmospheric pressure decreased the round-room tritium levels increased). Evidence was collected which indicated that water condensed on the underside of the Cell 12-44-1 dome gulf seal layer and drained down to its edge, accumulating in the soil-backfill around the Cell 12-44-1 dome.

Samples of the round room and dome air found both elemental (gaseous) tritium and oxidized tritium (tritiated water). The ratio of gaseous to oxidized tritium varied from 0.1 to 10. All surface contamination was attributed to tritiated water deposition.

Exterior to the Cell 12-44-1 complex, low but elevated tritium levels were found in a drainage ditch between Buildings 12-42 and 12-95 (see Figure A.1). The low area to which the ditch drains was found to have higher readings than the ditch itself. In addition, the ground to which the Cell 12-44-1 humidifier condensate is released was contaminated to a depth of 54 in. The humidifier was operational during a portion of the period immediately following the release.

2.3.3 Environmental Measurements

Air, vegetation, and soil monitoring has taken place in the vicinity of Cell 12-44-1. Air monitoring station PA-06 is located approximately 100 m south of the cell. Weekly tritium levels measured at this station are presented in Figure 2.1 and Table 2.1 for the years 1989 to 1992. The values in Figure 2.1 are truncated between 0 and $1\text{E-}15$ Ci/mL to facilitate the visualization of trends. The arrow in Figure 2.1 indicates the week in 1989 when the accident occurred. In addition to the Cell 12-44-1 tritium releases, tritium releases from calibration activities in building 12-53 and other Plant-wide tritium releases may be measured at station PA-06.

The routine measurements of tritium in the air are collected with low-volume air samplers that extract atmospheric water. A silica gel column in

the samplers removes water vapor from the air. The moisture is then recovered from the silica and analyzed for tritium content. This method of collection recovers tritium oxide, but not tritium gas, from the atmosphere.

After media samples were collected, the moisture was extracted from the sample and evaluated for tritium content. The soil and vegetation monitoring results presented in Appendix A indicate the activity normalized to a mL of water. Monitoring data are further discussed in Section 4.0.

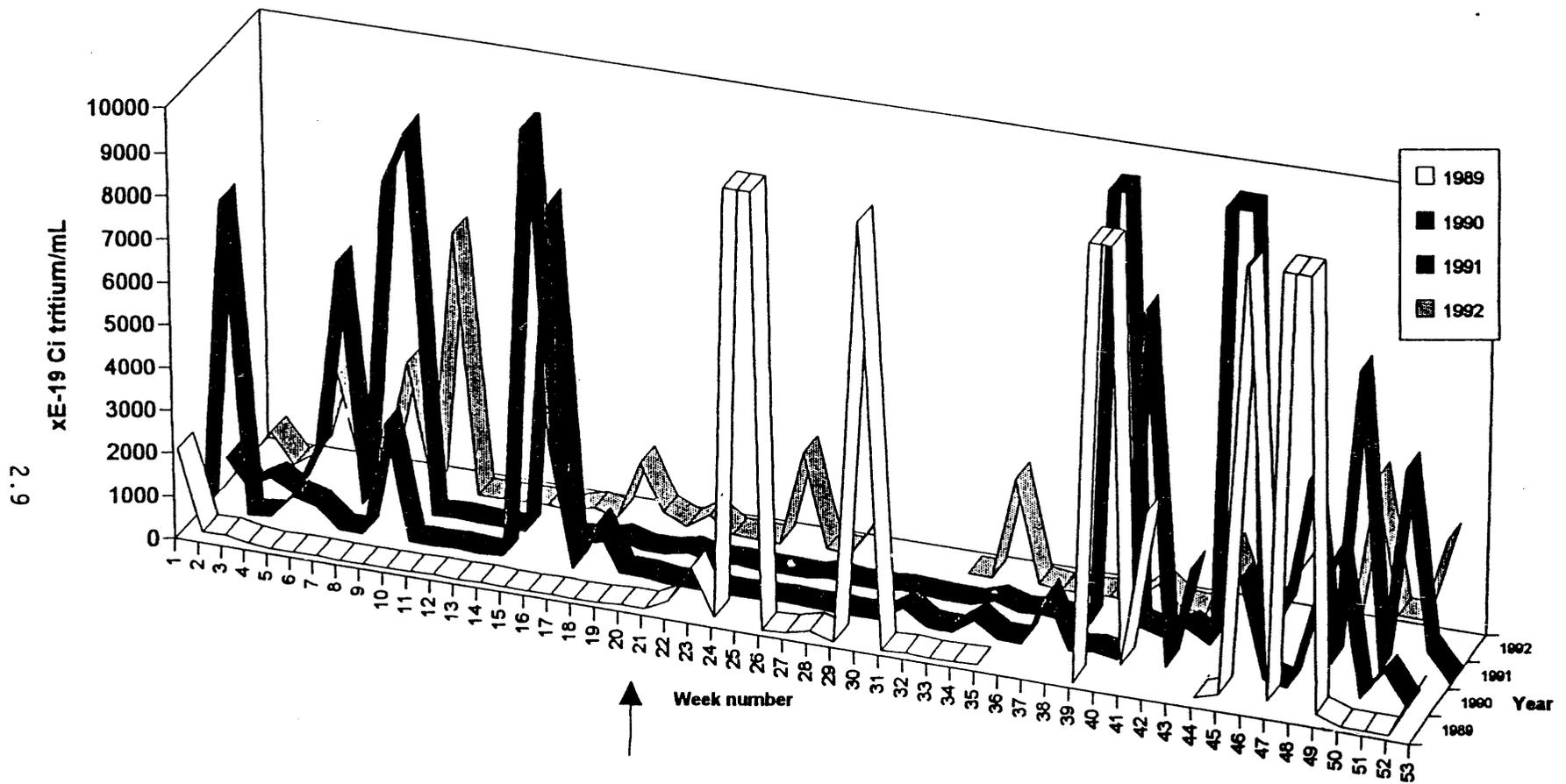


FIGURE 2.1. Tritium Measurements from Air Monitoring Station PA-06, 1989 to 1992 (The arrow indicates the week of the initial release in 1989.)

TABLE 2.1. Tritium Measured at Air Monitoring Station PA-06, 1989 to 1992
 (Blanks indicate dates when no measurements were recorded.
 Measurements are in units of 10^{-19} Ci/mL.)

| 1989 | | 1990 | | 1991 | | 1992 | |
|--------|--------|--------|---------|--------|-------|--------|--------|
| 3-Jan | 136.2 | 2-Jan | 35.2 | 2-Jan | 612 | 7-Jan | 4.1 |
| 10-Jan | 156.4 | 9-Jan | 7342.7 | 8-Jan | 0 | 14-Jan | 712.3 |
| 17-Jan | 51.1 | 16-Jan | 28 | 15-Jan | 302 | 21-Jan | 7 |
| 24-Jan | 9.9 | 23-Jan | 78 | 22-Jan | 36.4 | 28-Jan | 397.6 |
| 31-Jan | 25.5 | 31-Jan | 642.5 | 31-Jan | 1190 | 4-Feb | 2313.9 |
| 7-Feb | 23.9 | 9-Feb | 487.1 | 5-Feb | 5650 | 11-Feb | 1.9 |
| 14-Feb | 5.1 | 13-Feb | 21.7 | 12-Feb | 29.8 | 18-Feb | 404.9 |
| 21-Feb | 6.9 | 21-Feb | 13 | 19-Feb | 7680 | 25-Feb | 2892.4 |
| 28-Feb | 4.6 | 27-Feb | 2706.3 | 28-Feb | 8940 | 3-Mar | 8.1 |
| 7-Mar | 7.1 | 6-Mar | 21.9 | 6-Mar | 28.2 | 10-Mar | 6109.5 |
| 14-Mar | 32.5 | 13-Mar | 8.7 | 12-Mar | 52.9 | 17-Mar | 14 |
| 21-Mar | 7.8 | 20-Mar | 31.6 | 20-Mar | 18.2 | 24-Mar | 6.9 |
| 28-Mar | 32.5 | 27-Mar | -2.9 | 31-Mar | 5.8 | 31-Mar | 19.7 |
| 4-Apr | 6.9 | 4-Apr | 34.2 | 2-Apr | 12.5 | 7-Apr | 33.6 |
| 11-Apr | 4.7 | 10-Apr | 11188.4 | 9-Apr | 7730 | 14-Apr | -5.4 |
| 18-Apr | 19.8 | 17-Apr | 2797.1 | 16-Apr | 5.24 | 21-Apr | 141.2 |
| 26-Apr | 5 | 24-Apr | 19.9 | 23-Apr | 12 | 28-Apr | 6.1 |
| 2-May | 9.4 | 1-May | 1118.8 | 30-Apr | 150 | 5-May | 1364.7 |
| 9-May | 51 | 8-May | 89.7 | 7-May | 6.4 | 14-May | 311.3 |
| 16-May | 42.9 | 15-May | 82.8 | 14-May | 11.1 | 21-May | 55.4 |
| 23-May | 296 | 22-May | 14.5 | 21-May | 124 | 28-May | 400.9 |
| 30-May | 1174 | 29-May | 6.6 | 28-May | -2.54 | 4-Jun | 39 |
| 6-Jun | 126.4 | 5-Jun | -0.5 | 4-Jun | 42.6 | 11-Jun | 20.9 |
| 14-Jun | 23560 | 12-Jun | 6.4 | 11-Jun | 1.11 | 18-Jun | 7.4 |
| 20-Jun | 16.7 | 19-Jun | 12.3 | 18-Jun | 10 | 25-Jun | 2207 |
| 27-Jun | 50.6 | 26-Jun | 46.7 | 25-Jun | -10.5 | 2-Jul | 73.6 |
| 5-Jul | 174.8 | 3-Jul | 18.9 | 2-Jul | 81 | 9-Jul | 22.4 |
| 11-Jul | 29.8 | 10-Jul | 10 | 9-Jul | 15.7 | 16-Jul | 846.8 |
| 18-Jul | 9712.2 | 17-Jul | 5.6 | 16-Jul | 2.18 | 23-Jul | |
| 25-Jul | 12.3 | 24-Jul | 10 | 23-Jul | 64.8 | 30-Jul | -3.6 |
| 1-Aug | 50.5 | 31-Jul | 350.9 | 30-Jul | 29.7 | 6-Aug | |
| 8-Aug | 11 | 7-Aug | 16.3 | 6-Aug | -6.68 | 13-Aug | 30.8 |
| 15-Aug | 29.1 | 14-Aug | -18.6 | 13-Aug | -7.29 | 20-Aug | 22.7 |
| 22-Aug | 49.8 | 21-Aug | 337.5 | 20-Aug | 158 | 27-Aug | 2383.1 |
| 29-Aug | | 28-Aug | 13.4 | 27-Aug | 2.43 | 3-Sep | 50 |
| 5-Sep | 394.9 | 4-Sep | -2.1 | 3-Sep | 34.4 | 10-Sep | -1.8 |
| 13-Sep | | 11-Sep | 1153.9 | 10-Sep | -9.58 | 17-Sep | -1.3 |
| 19-Sep | 12.5 | 18-Sep | 21.5 | 17-Sep | 24.4 | 24-Sep | 28.1 |
| 26-Sep | 18782 | 25-Sep | 89.2 | 24-Sep | 15800 | 1-Oct | 12 |
| 3-Oct | 585.6 | 2-Oct | 2.7 | 1-Oct | 148 | 8-Oct | 473 |
| 10-Oct | 4099 | 10-Oct | 8009.1 | 8-Oct | 0.28 | 15-Oct | 29.7 |
| 17-Oct | | 16-Oct | 18.7 | 15-Oct | 281 | 22-Oct | 1.1 |
| 25-Oct | 128.8 | 24-Oct | 2313.7 | 22-Oct | -4.22 | 29-Oct | 1540.1 |
| 31-Oct | 289.9 | 31-Oct | | 29-Oct | 22500 | 5-Nov | 35.5 |
| 7-Nov | 10491 | 6-Nov | 2256.4 | 5-Nov | 30.6 | 12-Nov | 577.6 |
| 14-Nov | 317.9 | 13-Nov | 112.8 | 12-Nov | 980 | 19-Nov | 1407 |
| 21-Nov | 23842 | 20-Nov | 5.3 | 19-Nov | 4080 | 24-Nov | |
| 28-Nov | 190.7 | 27-Nov | 1880.3 | 26-Nov | 7.76 | 3-Dec | 162.9 |
| 5-Dec | 0 | 4-Dec | 3240.2 | 3-Dec | 6740 | 10-Dec | 3687.9 |
| 12-Dec | 0 | 11-Dec | 44.9 | 10-Dec | 5.8 | 17-Dec | 663.8 |
| 19-Dec | 0 | 18-Dec | 710.3 | 17-Dec | 4680 | 24-Dec | 683.8 |
| 26-Dec | 1017.3 | 26-Dec | 4 | 24-Dec | 655 | 31-Dec | 2544.6 |
| | | | | 31-Dec | 0.19 | | |

3.0 ASSESSMENT OF TRITIUM RELEASE

The current assessment of the Cell 12-44-1 tritium release was conducted using the MEPAS (Multimedia Environmental Pollutant Assessment System) (Buck et al. 1989, Droppo et al. 1989) and GENII (GENeration II) (Napier et al. 1988) computer codes. The MEPAS code was used because it best addressed the scenario of an underground release diffusing to the surface in situations where several layers of non-soil material covered the site of release. The GENII code addressed atmospheric dispersion, as well as the environmental accumulation and doses resulting from the tritium releases. The code calculations indicate the effective dose equivalent to the MEI for the years 1990 to 1992. These results are then used to estimate subsequent years' MEI doses.

Generally, computer codes used for dose assessments are developed to model a finite sample of release and exposure scenarios. No code models every possible release and exposure situation. Therefore, a "conceptual model" of the release must be developed that utilizes the scenarios implemented in the code to be used for the assessment.

The conceptual model used for the MEI doses for 1990 and subsequent years resulting from Cell 12-44-1 releases is an underground tritium source being slowly (i.e., chronically) released to the atmosphere through the Cell 12-44-1 dome at a uniform rate. The tritium, in the form of either HT or HTO, is contained by two thick layers of gravel, a thinner layer of concrete, and a layer of tar and paper which make up the dome. The concrete is assumed to be the least permeable of all of the dome layers and limits the rate of tritium release to the atmosphere.

The dose to the MEI from the release is evaluated by multiplying the activity release rate by a dilution factor specific to the MEI location. The dilution factor was developed with consideration for the Pantex-specific meteorology during the three-year period from 1990 to 1992. The product of the release rate and dilution factor is the average annual air concentration at the MEI location. The MEI external exposure, inhalation, and ingestion doses were estimated based on this average annual air concentration.

The MEPAS and GENII codes were used to estimate the annual average air concentration at the location of the MEI. The MEI location was previously determined to be 1900-m ESE of Cell 12-44-1 (M&H 1991). To calculate bounding dose estimates resulting from the Cell 12-44-1 release, the MEI was assumed to be exposed to releases of both forms of environmental tritium, HT and HTO. Then, the MEI air concentrations of tritium were, again, used with the GENII code for the dose assessment. The air monitoring station located in the vicinity of Cell 12-44-1 permitted the validation of model results, thereby implicitly confirming the adequacy of the model assumptions.

3.1 TRITIUM RELEASE RATE ESTIMATION

The release rates of tritium through the dome above the round room of Cell 12-44-1 were estimated by using a modified MEPAS methodology. Since there is sufficient reason to believe that the tritium gas released was, to some extent, converted to tritium oxide, the release rates of both tritium gas and tritium oxide were estimated. The difference in ground release rates between tritium and tritium oxide mainly results from the difference in the diffusion coefficient through the air pore spaces in the cover material above the round room. As a conservative assumption, all emanations of either tritium or tritium oxide from the soil were assumed to be in the form of tritium oxide at the point in which it became available for atmospheric dispersion.

The method of estimating release rates of gaseous compounds follows that documented in MEPAS. However, MEPAS can at present only handle the situation where the cover material above the source is a single layer of uniform composition. This feature had to be modified to incorporate multiple layers of diffusion barriers, as is the case of the Cell 12-44-1 round room dome. The modification is as follows in accordance with the procedure in *The Mathematics of Diffusion* (Crank 1985):

$$F = \frac{\Delta C}{\sum \frac{\ell_i}{D (P_a^{10/3}/P_t^2)_i}} \quad (1)$$

where F = release rate of tritium (or tritium oxide), mass per unit area per unit time

ΔC = difference of tritium (or tritium oxide) concentration in the air between the round room ceiling and the dome surface in contact with the atmosphere, activity per unit volume of air

D = molecular diffusivity of tritium (or tritium oxide) in air, length squared per unit time

ℓ_i = thickness of each layer i of the dome cover material above the round room, length

P_a = air filled porosity of each layer of the dome cover material, dimensionless

P_t = total porosity of each layer of the dome cover material, dimensionless

It was then assumed that the pores in the air space of the dome cover material are relatively dry (a conservative assumption). Therefore, Equation (1) can be simplified to:

$$F = \frac{\Delta C}{\sum \frac{\ell_i}{D \epsilon_i^{4/3}}} \quad (2)$$

where ϵ = porosity of each layer of the dome cover material, dimensionless. This equation was then used to determine the release rate of tritium (or tritium oxide) from Cell 12-44-1.

The dome cover material consists of four layers. Exact information on the porosities of the dome cover materials was not available. The assumptions about the layers shown in Table 3.1 were made for the release rate model (layers are listed in order of increasing depth from the surface).

TABLE 3.1. Assumed Thickness and Porosity of the Dome Layers

| Layer Material | Thickness | Porosity (fraction) |
|-------------------------|-----------|--|
| Tar & Paper (gulf seal) | 0.5 mm | Equivalent soil thickness: 6.7 cm with porosity of 0.35 |
| Cement layer (Gunite) | 3 inches | Varied |
| Gravel dome layer 1 | 1.5 feet | 0.35 |
| Gravel dome layer 2 | 18.5 feet | 0.35 |

The thickness of the gulf seal was adjusted to an equivalent soil layer thickness, as recommended by EPA (Farmer et al. 1980). In brief, the equivalent soil layer thickness equals $134.6 \times h_f$, where h_f is the thickness of a plastic membrane (mm). The gulf seal was assumed to resemble a plastic membrane material. The diameter of each dome layer was assumed to be 34 ft, the same diameter as the round room.

The porosities of the Gunite layer could vary from less than 1% to greater than 10% (KCG 1972). Gunite is pneumatically placed concrete, much used for placing or repairing reservoir walls and canal and tunnel linings, placing fire-proofing or protective layers over structural steel, repairing faces of dams, and restoring reinforced concrete members of buildings that have undergone serious fire damage. For the purpose of estimating release rates of tritium and tritium oxide, the values for porosities of Gunite were varied to determine the variations of emission rates for the expected range of porosities. These plots were generated because of the lack of site-specific porosity data for the dome materials.

The release rates for tritium and tritium oxide were separately prepared, as shown in the Figures 3.1 and 3.2. In generating these figures, the concentration of radioactivity at the Cell 12-44-1 dome air was also varied because the monitored dome air concentrations of tritium varied from 14 to $90 \mu\text{Ci}/\text{m}^3$ (AWC 1990). Two major assumptions were required to model the tritium release rates: the dome material porosity and the area of release. The most uncertainty exists in the assumption that the area of release was the size of the Cell 12-44-1 round room.

The above information was used to estimate the tritium release rate from the dome. Once the release rate estimate has been calculated, it can be coupled with site-specific meteorologic monitoring data using the GENII code to determine the air concentration at the location of the MEI.

GENII has the capability of accepting the joint frequency data (i.e., meteorologic data) of the annual wind speeds based on stability classes, directions, and wind speed categories. The average 1990, 1991, and 1992 joint frequency data at the Pantex Plant were used to generate the mean $\bar{\chi}/Q'$ value (i.e., a "dilution factor") for the MEI location. The GENII output showing the average $\bar{\chi}/Q'$ values at various distances and directions from the release are shown in Table 3.2. This output was used to estimate the air concentrations of tritium at a specific receptor point, the MEI location, by multiplying the appropriate $\bar{\chi}/Q'$ value by the estimated release rate of tritium or tritium oxide.

3.2 TRITIUM CONCENTRATIONS IN AIR AT THE MEI LOCATION

The air concentrations at the MEI location were estimated from the bounding Cell 12-44-1 tritium release rates of 0.005 to 0.035 $\mu\text{Ci/s}$ for tritium and 0.002 to 0.013 $\mu\text{Ci/s}$ for tritium oxide calculated using the above methodology. These release rates were observed at the maximum, modeled Gunite porosity (10%) and the observed range of activity levels (14 to 90 $\mu\text{Ci/m}^3$) in the dome air (see Figures 3.1 and 3.2).

The $\bar{\chi}/Q'$ for the MEI location (1900-m ESE of Cell 12-44-1) was calculated to be $3.65\text{E-}7 \text{ s/m}^3$ (see Table 3.2), using the average meteorology from 1990 to 1992. The resulting tritium air concentrations at the MEI location estimated from the release rate and appropriate $\bar{\chi}/Q'$ are:

| | |
|--|-------------------------|
| minimum (release rate = 0.002 $\mu\text{Ci/s}$) | 7.3E-4 pCi/m^3 |
| maximum (release rate = 0.035 $\mu\text{Ci/s}$) | 1.3E-2 pCi/m^3 |

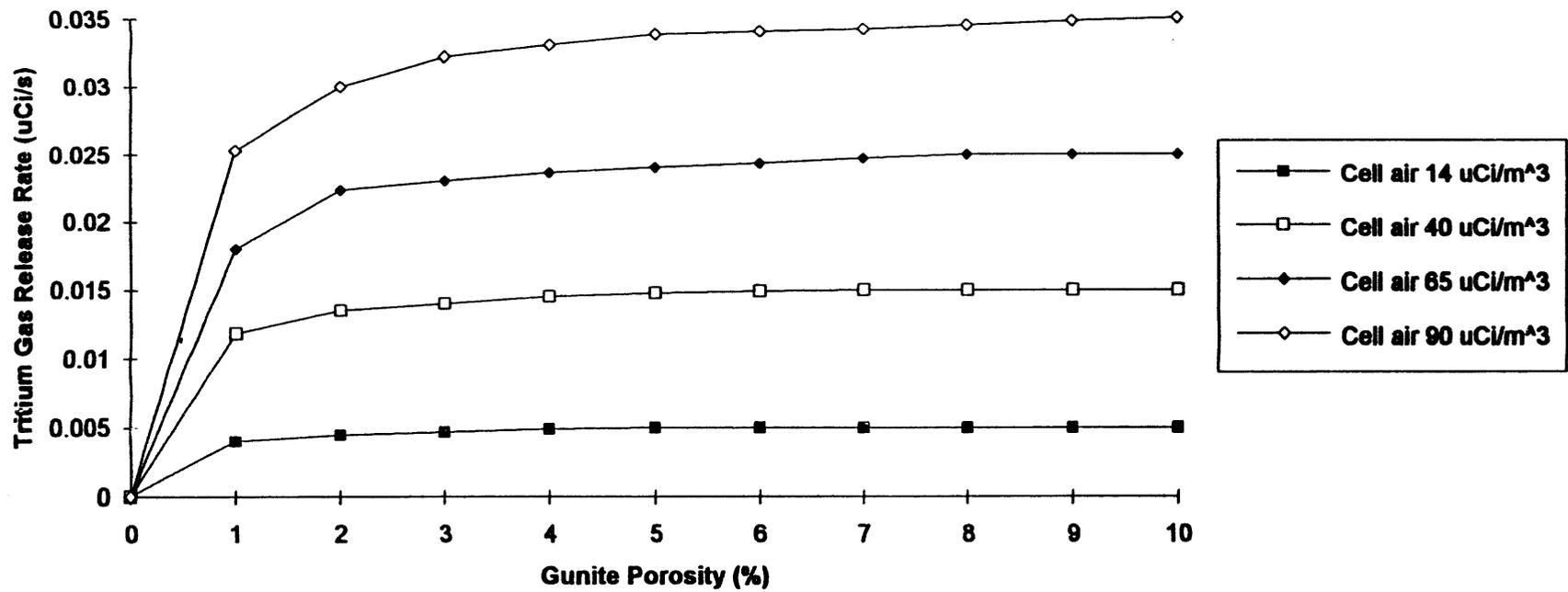


FIGURE 3.1. Tritium Gas Release Rate vs. Porosity of Gunite at Different Ceiling Air Concentrations

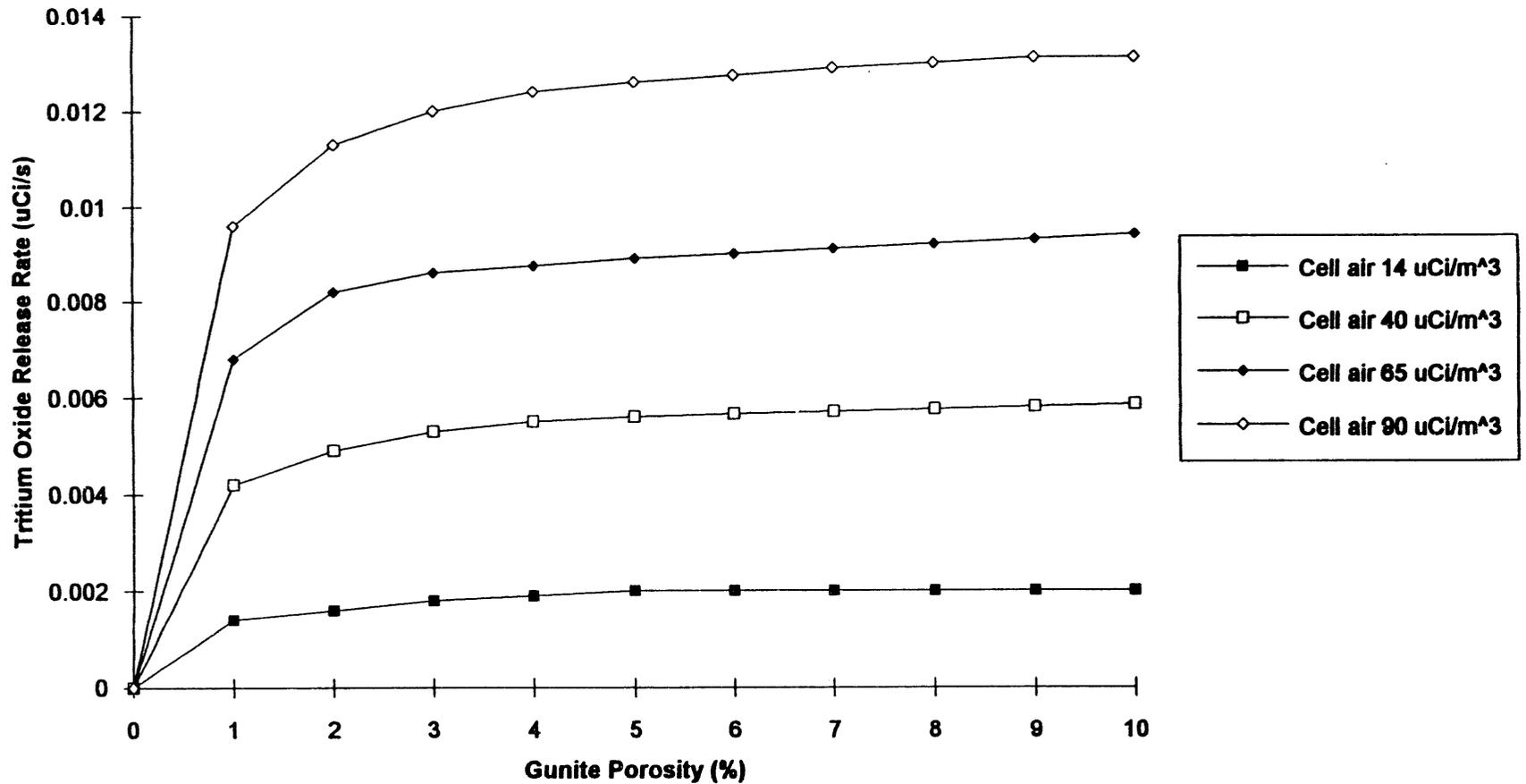


FIGURE 3.2. Tritium Oxide Release Rate vs. Porosity of Gunite at Different Ceiling Air Concentrations

TABLE 3.2. Annual Average Atmospheric Dispersion Values (\bar{x}/Q' Values), 1990 to 1992, by Direction of Release

| Distance from release (m) | S | SSW | SW | WSW | W | WNW | NW | NNW |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 100 | 8.18E-05 | 8.55E-05 | 7.99E-05 | 7.31E-05 | 3.79E-05 | 4.19E-05 | 6.59E-05 | 9.95E-05 |
| 1900 | 4.13E-07 | 4.32E-07 | 4.04E-07 | 3.75E-07 | 1.87E-07 | 2.09E-07 | 3.36E-07 | 4.99E-07 |
| 4023 | 1.26E-07 | 1.32E-07 | 1.24E-07 | 1.16E-07 | 5.76E-08 | 6.42E-08 | 1.03E-07 | 1.51E-07 |
| 5632 | 7.53E-08 | 7.89E-08 | 7.42E-08 | 7.05E-08 | 3.47E-08 | 3.86E-08 | 6.19E-08 | 9.02E-08 |
| 7241 | 5.16E-08 | 5.41E-08 | 5.10E-08 | 4.88E-08 | 2.40E-08 | 2.66E-08 | 4.25E-08 | 6.17E-08 |
| 12068 | 2.43E-08 | 2.55E-08 | 2.42E-08 | 2.35E-08 | 1.15E-08 | 1.27E-08 | 2.01E-08 | 2.88E-08 |
| 24135 | 8.95E-09 | 9.43E-09 | 9.04E-09 | 8.99E-09 | 4.34E-09 | 4.76E-09 | 7.48E-09 | 1.05E-08 |
| 40255 | 4.36E-09 | 4.60E-09 | 4.45E-09 | 4.50E-09 | 2.16E-09 | 2.35E-09 | 3.66E-09 | 5.09E-09 |
| 56315 | 2.73E-09 | 2.89E-09 | 2.81E-09 | 2.87E-09 | 1.37E-09 | 1.49E-09 | 2.30E-09 | 3.18E-09 |
| 72405 | 1.93E-09 | 2.05E-09 | 2.00E-09 | 2.06E-09 | 9.82E-10 | 1.06E-09 | 1.63E-09 | 2.24E-09 |

| Distance from release (m) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 100 | 1.48E-04 | 1.77E-04 | 1.29E-04 | 7.30E-05 | 6.26E-05 | 7.25E-05 | 7.84E-05 | 7.89E-05 |
| 1900 | 7.56E-07 | 9.04E-07 | 6.56E-07 | 3.65E-07 | 3.17E-07 | 3.65E-07 | 4.01E-07 | 4.05E-07 |
| 4023 | 2.30E-07 | 2.76E-07 | 2.00E-07 | 1.12E-07 | 9.75E-08 | 1.12E-07 | 1.23E-07 | 1.24E-07 |
| 5632 | 1.38E-07 | 1.65E-07 | 1.20E-07 | 6.69E-08 | 5.86E-08 | 6.71E-08 | 7.43E-08 | 7.48E-08 |
| 7241 | 9.42E-08 | 1.13E-07 | 8.19E-08 | 4.59E-08 | 4.04E-08 | 4.61E-08 | 5.12E-08 | 5.15E-08 |
| 12068 | 4.42E-08 | 5.31E-08 | 3.85E-08 | 2.17E-08 | 1.92E-08 | 2.18E-08 | 2.44E-08 | 2.45E-08 |
| 24135 | 1.62E-08 | 1.95E-08 | 1.42E-08 | 8.06E-09 | 7.23E-09 | 8.14E-09 | 9.14E-09 | 9.14E-09 |
| 40255 | 7.86E-09 | 9.46E-09 | 6.90E-09 | 3.95E-09 | 3.57E-09 | 4.00E-09 | 4.51E-09 | 4.49E-09 |
| 56315 | 4.91E-09 | 5.91E-09 | 4.32E-09 | 2.48E-09 | 2.26E-09 | 2.52E-09 | 2.85E-09 | 2.83E-09 |
| 72405 | 3.47E-09 | 4.17E-09 | 3.05E-09 | 1.76E-09 | 1.61E-09 | 1.79E-09 | 2.03E-09 | 2.01E-09 |

To estimate the dose to the MEI, GENII dose estimates were calculated by assuming the MEI was chronically exposed to the above tritium oxide air concentrations. The GENII exposure scenario was run as a "base-case," where the individual was chronically exposed to a unit concentration of tritium in the air (1 Ci/m^3). Appendix B provides the base-case output file. The MEI dose is proportional to the results of this base-case scenario. The range of final dose estimates is calculated by multiplying the base-case dose by the range of estimated MEI air concentrations (i.e., $7.3\text{E-}4 \text{ pCi/m}^3$ and $1.3\text{E-}2 \text{ pCi/m}^3$). The modelled MEI exposure pathways were inhalation of the air, external exposure to the air, and ingestion of food products (i.e., leafy vegetables, other vegetables, fruit, meat, and poultry) that were grown at the location of the MEI.

The resulting average annual dose to the MEI for the years 1990 to 1992 ranges from $4\text{E-}6$ to $7\text{E-}5$ mrem. These doses are well below the most restrictive offsite individual dose limit of the EPA for airborne releases from DOE facilities, i.e., 10 mrem (40 CFR 61).

The MEI doses for years after 1992 could be estimated after considering the above dose assessment results and conclusions. The doses would be expected to be smaller than the 1990 to 1992 dose estimates as a result of diffusion, long-term entrainment of the Cell 12-44-1 tritium inventory, and radiological decay. Since the annual average 1990 to 1992 dose estimate is negligible compared to the regulatory dose limit, it is sufficient to report that the doses resulting from the Cell 12-44-1 tritium releases for years following 1992 do not warrant additional consideration.

The accuracy of the dose estimates can be supported through the use of the tritium air sample measurements of air monitoring station PA-06. The monitoring data can be used to "calibrate" the modeled air concentration estimate of the MEI location. Thereby, the dose to the MEI resulting from the modeled air concentration can be calibrated.

3.3 CALIBRATION OF MODEL ESTIMATES

Air monitoring data from station PA-06, located 100 m south of Cell 12-44-1, was used to validate the modeled release rate estimates. The \bar{x}/Q' considering the 1990 to 1992 meteorology at the Pantex Plant for the location 100-m south was determined to be $8.18E-5 \text{ s/m}^3$ (see Table 3.2). The product of the release rate and the \bar{x}/Q' produces the model estimate of the average air concentration at station PA-06. The range of air concentrations at PA-06, using the minimum ($0.002 \text{ } \mu\text{Ci/s}$) and maximum ($0.035 \text{ } \mu\text{Ci/s}$) Cell 12-44-1 tritium release rates, produces tritium air concentration model estimates of $1.6E-13 \text{ Ci/m}^3$ and $2.9E-12 \text{ Ci/m}^3$, respectively. Use of the tritium gas release estimates would assume all the tritium gas released from the dome was converted to tritiated water at the soil-air interface, since the monitoring station measurements indicate only the level of tritium oxide in the air.

The median tritium concentrations measured at station PA-06 were as follows:

- for 1990, $3.2E-12 \text{ } \mu\text{Ci/mL}$ (3.2 pCi/m^3)
- for 1991, $2.9E-12 \text{ } \mu\text{Ci/mL}$ (2.9 pCi/m^3) (BP and M&H 1992), and
- for 1992, $5.0E-12 \text{ } \mu\text{Ci/mL}$ (5.0 pCi/m^3).

The medians rather than the mean PA-06 measurements are used because of the skewing effect of outliers. The comparison of the model and actual measurements are found in Table 3.3.

TABLE 3.3. Comparison of the Model and Actual Measurements of Median Tritium Concentrations at Station PA-06, 1990-1992

| <u>Year</u> | <u>Model Estimates</u> (<u>pCi/m^3</u>) | <u>Actual Measurements</u> (<u>pCi/m^3</u>) | <u>Ratio model:actual</u> |
|-------------|--|--|---------------------------|
| 1990 | 0.16 to 2.9 | 3.2 | 0.05 to 0.91 |
| 1991 | 0.16 to 2.9 | 2.9 | 0.055 to 1.0 |
| 1992 | 0.16 to 2.9 | 5.0 | 0.032 to 0.58 |

The model estimates of the average air concentration at monitoring station PA-06 are underestimates of the measured air concentrations. The differences could result from

- underestimation of the dome materials' porosity
- underestimation of the area of tritium release.

The ratio of the modeled-to-actual air concentrations can be used to estimate a "calibration factor" for use in adjusting the modeled MEI dose estimates upward. The overall average ratio is 0.44. The calibration factor adjusts for the dome material porosity and area of release assumptions. Applying this calibration factor to the modeled dose estimates provides a "calibrated" dose estimate of $9E-6$ to $2E-4$ mrem to the MEI for the years 1990 to 1992. This calibrated dose estimate is still well below the regulatory dose limit.

3.4 DOSE ASSESSMENT CONCLUSIONS

The re-assessed 1990 to 1992 doses to the MEI from the tritium released from the Cell 12-44-1 incident are well below EPA and DOE regulatory dose limits for offsite individuals. The low dose estimates and acute release of the tritium in 1989 suggest that the estimation of the doses from the current tritium releases no longer warrant their distinct calculation in the Pantex ASER.

This conclusion would apply so long as decontamination and decommissioning activities are not initiated. Remediation activities may increase the dispersal of the Cell 12-44-1 soil-entrapped tritium into the atmosphere. In the event of remediation, additional monitoring stations may be installed in the immediate area, depending on the remediation activity. Dose assessments would use this monitoring data to indicate any changes in the offsite impact.

4.0 ENVIRONMENTAL MONITORING

There are six general objectives of environmental monitoring programs (Denham 1982):

1. Assessment of actual or potential exposure of people to radioactive materials released to the environment as a result of nuclear facility operations.
2. Evaluation of long-term trends of concentrations in the environment with the intent of detecting failures or the lack of adequate control of releases and to initiate appropriate actions.
3. Determination of the fate of contaminants released to the environment, especially with the intention of discovering previously uncovered mechanisms of exposure.
4. Maintenance of a database and capabilities for rapid evaluation and response to unusual releases of radioactivity.
5. Detection and evaluation of radioactivity from offsite sources in order to distinguish and compare the results of onsite operations.
6. Demonstration of compliance with the applicable regulations concerning releases to the environment, for both legal and public relations purposes.

In addition, environmental monitoring (EM) activities should be supported by documentation of monitoring location selection criteria and a general EM quality assurance plan (Denham and Kathren 1989).

The environmental monitoring conducted to evaluate the tritium releases resulting from the Cell 12-44-1 incident has applications to several of the above objectives. General EM program objectives 1, 2, 4, and 6, listed above, should reflect the intentions of the environmental monitoring actions related to the Cell 12-44-1 incident. Each of these objectives will be reviewed with respect to how they might be applied to the evaluation and monitoring of releases similar to that of the Cell 12-44-1 incident.

Objective 1. Assessing actual or potential exposure. The monitoring performed in the immediate vicinity of the release site provides near-field exposure information. All offsite individuals will be exposed to a minor fraction of the activity measured in this near-field environment, primarily as a result of distance.

Objective 2. Evaluation of long-term trends. The near-field monitoring can provide information about the "release profile" (i.e., emission rate trends over time). In the event of future larger releases, the timing of remedial actions may be deduced from spatial, seasonal, and temporal patterns. For example, remediation can be conducted during conditions of minimal atmospheric releases, in order to limit atmospheric dispersal of the material.

Objective 4. Maintenance of database and capabilities. This objective may more appropriately be labelled "Lessons Learned." The monitoring program and data should provide information upon which to base future monitoring programs in the event of a similar incident.

Objective 6. Demonstration of regulatory compliance. Computer codes are used to evaluate the numerous environmental pathways in which tritium releases can accumulate and produce potential exposures to the local population. Environmental measurements may be used to estimate doses. Computer codes are used to generate dose estimates when monitoring data are unavailable or inadequate. Lack of information and the inherent variability in meteorological and biotic processes prevents the dose calculations from being more than simply dose estimates. Depending on the input, the models generally vary from "somewhat" to very conservative (i.e., over-estimations). Therefore, assuming the exposure scenario was defined as accurately as possible, there is a safety-factor in the final dose estimates to the MEI that are compared to the regulatory dose limits.

4.1 USE OF PAST ENVIRONMENTAL MEASUREMENTS

Air, soil, and vegetation samples from the vicinity of Cell 12-44-1 were monitored in the past (see Section 2.3.3 and Appendix A). The results of these measurements are evaluated in this section as a rejoinder to general EM objective 4, the "lessons learned" objective.

4.1.1 Air Monitoring

The 1990, 1991, and 1992 routine air monitoring measurements of station PA-06, 100-m south of Cell 12-44-1, are shown in Figure 2.1. One feature clearly evident in Figure 2.1 is the lack of winds blowing toward this air

monitoring station in the summer. The summer wind rose shown in M&H (1991) indicates the preponderance of winds from the south during the summer.

Future air monitoring conducted for the purposes of follow-up to radioactive material release incidents should assure that the monitoring station is located to monitor the most prevalent wind directions. Seasonal trends may create the need for more than one air monitoring station. This would assure adequate monitoring coverage of the releases to the atmosphere.

4.1.2 Soil and Vegetation Monitoring

The non-routine soil and vegetation monitoring data taken in response to the Cell 12-44-1 incident are tabulated in Appendix A. The sample turn-around time, vegetation availability, and marked programmatic changes in the EPD since May 1989 are believed to account for the scattered sampling frequencies at various sampling locations. Seasonal release trends cannot be distinguished from the available data because of the fragmented sampling frequency and sampling location coverage over time.

Future EPD soil and vegetation monitoring of similar releases should be planned so that seasonal release trends can be deduced. The plan should include the requirement for data compilation in a database created specifically for the purpose of trending evaluations. A single EPD staff member should be assigned the responsibility of data compilation, data evaluation, and reporting.

4.2 ENVIRONMENTAL MONITORING CONCLUSIONS

The probability of a similar tritium release occurring in the future was further reduced in response to the Cell 12-44-1 incident. Nuclear component tritium containment continues to be evaluated in the cell structures at the Pantex Plant. Therefore, despite this risk reduction, a potential for a similar release scenario is still present. In the event of a repeat release, monitoring should be conducted to assure that seasonal trends can be deduced from the air, soil, and vegetation monitoring data.

The monitoring of seasonal trends are important for the assessment of doses to the offsite public and for remediation planning. The GENII output file of the base-case evaluation of offsite doses (Appendix B) indicates the

dose contribution from the inhalation, ingestion, and external exposure pathways. The greatest contributor to the MEI dose is from ingestion of "other vegetables" (i.e., non-leafy vegetables) and fruit. If the greatest releases of tritium to the atmosphere are found to occur during the local other-vegetable and fruit growing seasons, the public health protection actions taken would be more important than if the greatest tritium releases occurred during the non-growing seasons.

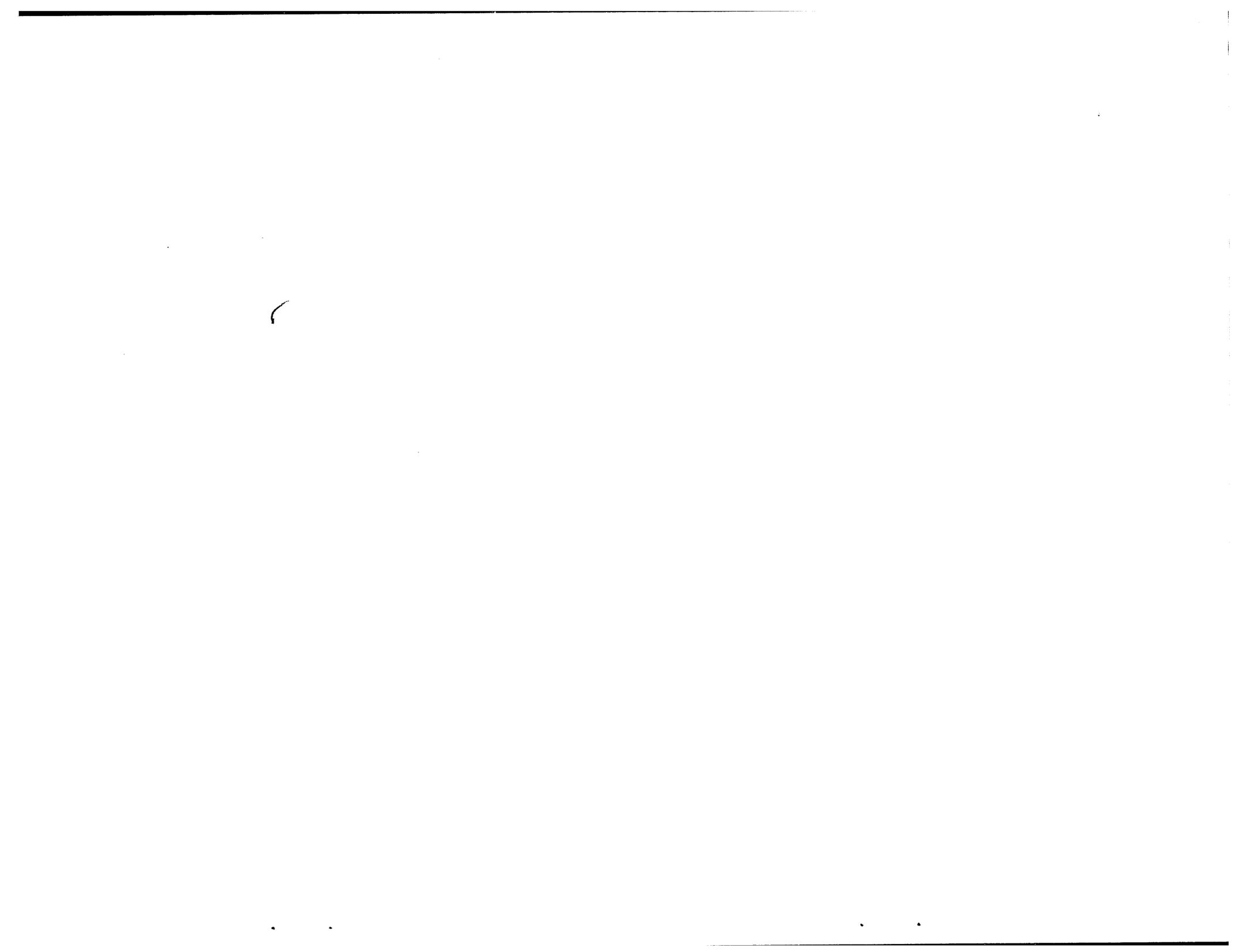
5.0 REFERENCES

- 40 CFR 61. 1990. U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants." U.S. Code of Federal Regulations.
- AWC Nuclear Services, Incorporated (AWC). 1990. *Radiological Survey and Characterization, Building 12-44, Cell One, Pantex Plant, Amarillo, Texas.* AWC Nuclear Services, Incorporated, Las Vegas, Nevada.
- Battelle Pantex and Mason & Hanger-Silas Mason Company, Incorporated (BP and M&H). 1992. *Pantex Plant Site Environmental Report for Calendar Year 1991.* Battelle Pantex, Amarillo, Texas.
- Battelle Pantex and Mason & Hanger-Silas Mason Company, Incorporated (BP and M&H). 1993. *Pantex Plant Site Environmental Report for Calendar Year 1992.* Battelle Pantex, Amarillo, Texas.
- Buck, J.W., B.L. Hoopes, and D.R. Friedrichs. 1989. *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance.* PNL-7136, Pacific Northwest Laboratory, Richland, Washington.
- Cember, H. 1987. *Introduction to Health Physics.* 2nd ed. Pergamon Press, New York.
- Crank, J. 1985. *The Mathematics of Diffusion.* Oxford Press, New York.
- Denham, D.H., and R.L. Kathren. 1989. "Recommended Protocol for Standardization in Collecting and Interpreting Radiological Environmental Data." In *Radiation Protection -- Theory and Practice*, proceedings of the Fourth International Symposium of the Society for Radiological Protection, Malvern 89, pp. 385-388. The Institute of Physics, Bristol, England.
- Denham, D.H., and D.A. Waite (compilers). 1982. "Environmental Sampling, Monitoring, and Analysis." In *CRC Handbook of Environmental Radiation*, ed. Alfred W. Klement, Jr., pp. 113-204. CRC Press, Boca Raton, Florida.
- Donham, B.J., P.Y. Pan, L.D. Rigdon, and F.A. Rockenbach. 1989. *FSAR for Pantex Building 12-44.* LATA-PTX-01-01, Issue A, Los Alamos Technical Associates, Incorporated, Los Alamos, New Mexico.
- Droppo Jr., J.G., D.L. Strenge, J.W. Buck, B.L. Hoopes, R.D. Brockhaus, M.B. Walter, and G. Whelan. 1989. *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance. Volume 2.* PNL-7216, vol. 2, Pacific Northwest Laboratory, Richland, Washington.
- Farmer, W.J., M-S. Yang, J. Letey, and W.F. Spencer. 1980. *Land Disposal of Hexachlorobenzene Wastes.* EPA-600/2-80-119, U.S. Environmental Protection Agency, Cincinnati, Ohio.

- Garland, J.A. 1979. "Transfer of Tritiated Water Vapor to and from Land Surfaces." In *Behavior of Tritium in the Environment*, Proceedings of a Symposium, San Francisco, 16-20 October 1978. International Atomic Energy Agency, Vienna.
- Hill, R.L. and J.R. Johnson. 1993. "Metabolism and Dosimetry of Tritium." *Health Physics* 65:628-647.
- Jacobs, D.G., C.E. Easterly, and J.E. Philips. 1979. "Influence of the Rate of Conversion of HT to HTO on Projected Radiation Doses from the Release of Molecular Tritium." In *Behavior of Tritium in the Environment*, Proceedings of a Symposium, San Francisco, 16-20 October 1978. International Atomic Energy Agency, Vienna.
- Kaiser Cement & Gypsum Corporation (KCG). 1972. "Concrete Topics, Kaiser Cement, Technical Service Department Bulletin Number 22."
- Kennedy, W.E., and D.L. Strenge. *Residual Radioactive Contamination from Decommissioning*. NUREG/CR-5512, vol. 1, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Mason & Hanger-Silas Mason (M&H). 1990. *Pantex Plant Site Environmental Report for Calendar Year 1989*. MHSMP-90-18, Mason & Hanger-Silas Mason Co, Inc., Pantex Plant, Amarillo, Texas.
- Mason & Hanger-Silas Mason (M&H). 1991. *Pantex Plant Site Environmental Report for Calendar Year 1990*. MHSMP-91-06, Mason & Hanger-Silas Mason Co, Inc., Pantex Plant, Amarillo, Texas.
- Napier, B.A., R.A. Peloquin, D.L. Strenge, and J.V. Ramsdell. 1988. *GENII - The Hanford Environmental Radiation Dosimetry System*. PNL-6548, Pacific Northwest Laboratory, Richland, Washington.
- Parks, B.S. 1992. *User's Guide for CAP88-PC. Version 1.0*. 402-B-92-001, U.S. Environmental Protection Agency, Las Vegas, Nevada.
- Peterman, B.F., J.R. Johnson, and R.G.C. McElroy. 1985. *Internal Dosimetry of Tritiated Hydrogen Gas*. CFFTP-G-84034/AECL-8651:1-45, Canadian Fusion Fuel Technology Project, Mississauga, Ontario, Canada.
- U.S. Department of Energy (DOE). 1988. *Internal Dose Conversion Factors for Calculation of Dose to the Public*. DOE/EH-0071, U.S. DOE, Washington, D.C.
- U.S. Department of Energy (DOE). 1990. "General Environmental Protection Program." DOE Order 5400.1.

APPENDIX A

SOIL AND VEGETATION MONITORING RESULTS



The soil and vegetation sampling points are indicated in Figure A.1. The figure indicates soil sampling point TS-SS-01 and vegetation sampling point TS-VG-01 at sampling point 1. The location of air monitoring station PA-06 is also indicated in Figure A.1 near sampling point 4.

PANTEX SOIL AND VEGETATION MONITORING AROUND CELL 1

Bold values indicate the average of the sample and its duplicate

| Soil Samples | (pCi/mL) | | | | | | | | | | | | | | | | | | | | | | | |
|--------------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 01-90 | 02-90 | 03-90 | 04-90 | 05-90 | 06-90 | 07-90 | 08-90 | 09-90 | 10-90 | 11-90 | 12-90 | 01-91 | 02-91 | 03-91 | 04-91 | 05-91 | 06-91 | 07-91 | 08-91 | 09-91 | 10-91 | 11-91 | 12-91 |
| Location | | | | | | | | | | | | | | | | | | | | | | | | |
| TS-SS-01 | | | | 1.1 | 2.1 | 1.1 | 0.25 | 0.45 | 3 | 4.2 | 3.5 | | | | 1.4 | | | 0.1 | | 0.31 | | | | |
| TS-SS-02 | | | | 2.4 | 2 | 2.7 | | | | | | | | | | | | 0.3 | | | | | | |
| TS-SS-03 | | | | 4.5 | 2.6 | 2.1 | | | | | | | | | | | | 0.45 | | | | | | |
| TS-SS-04 | | | | 8.8 | 6.1 | 3.2 | | | | | | | | | | | | 1.7 | | | | | | |
| TS-SS-05 | | | | 8.3 | 4.9 | 4 | | | | | | | | | | | | 1.2 | | | | | | |
| TS-SS-06 | | | | 17 | 15 | 11 | 4.8 | 6.7 | 16 | 25 | 29 | | | | 30 | | | 2.2 | | | | | | |
| TS-SS-07 | | | | 1.6 | 6.8 | -0.03 | | | | | | | | | 3.8 | | | 0.66 | | | | | | |
| TS-SS-08 | | | | 1.2 | 10 | 1.4 | 4.1 | 4.4 | | 2.8 | 5 | | | | 2.4 | | | 2.1 | | 1.5 | | | | |
| TS-SS-09 | | | | 3.3 | 10 | 12 | | | | | | | | | | | | 0.85 | | | | | | |
| TS-SS-10 | | | | 4.4 | 20 | 16 | | | | | | | | | | | | 1.1 | | | | | | |
| TS-SS-11 | | | | 4.5 | 67 | 9.8 | | | | | | | | | | | | 1.1 | | | | | | |
| TS-SS-12 | | | | 23 | 52 | 38 | | | | | | | | | | | | 6.1 | | 21 | | | | |
| TS-SS-13 | | | | 27 | 93 | 48.6 | | | | 81 | | | | | | | | 5.9 | | 35 | | | | |
| TS-SS-14 | | | | 4.6 | 19 | 8.7 | | | | | | | | | | | | 15 | | 15 | | | | |
| TS-SS-15 | | | | 2.4 | 6.2 | 2.8 | | | | | | | | | | | | 1.2 | | | | | | |
| TS-SS-16 | | | | 1.6 | 5.8 | 0.98 | | | | | | | | | | | | 0.64 | | | | | | |
| TS-SS-17 | | | | 2300 | 11000 | 7900 | | | | | | 4888 | | | 888 | | | 1000 | | 238 | | | | |
| TS-SS-18 | | | | 66 | 230 | 8.67 | | | | | | 81 | | | 54 | | | 7.7 | | 58 | | | | |
| TS-SS-19 | | | | 16 | 29 | 0.78 | | | | | | | | | | | | 4 | | 13 | | | | |
| TS-SS-20 | | | | 0.34 | 2.2 | 2.1 | | | | | | | | | | | | 0.53 | | | | | | |
| TS-SS-21 | | | | | | | | | | | | | | | | | | 1.3 | | | | | | |
| TS-SS-22 | | | | | | | | | | | | | | | | | | 0.64 | | | | | | |
| TS-SS-23 | | | | | | | | | | | | | | | | | | 0.94 | | | | | | |
| TS-SS-24 | | | | | | | | | | | | | | | | | | 0.22 | | | | | | |
| TS-SS-25 | | | | 0.17 | 0.79 | 0.94 | -0.12 | 0.15 | 0.4 | | | 0.44 | | | -0.16 | | | 0.65 | | | | | | |
| TS-SS-26 | | | | 23 | 78.6 | 0.79 | | | | | | | | | | | | 4.8 | | 8 | | | | |
| TS-SS-27 | | | | 19 | 70 | 1.2 | | | | | | | | | | | | 5.3 | | 46 | | | | |
| TS-SS-28 | | | | 13 | 48 | 0.08 | | | | | | | | | | | | 6.3 | | 7.2 | | | | |

A.1

A.2

| | 01-90 | 02-90 | 03-90 | 04-90 | 06-90 | 07-90 | 08-90 | 09-90 | 10-90 | 11-90 | 12-90 | 01-91 | 02-91 | 03-91 | 04-91 | 05-91 | 06-91 | 07-91 | 08-91 | 09-91 | 10-91 | 11-91 | 12-91 |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| TS-SS-29 | | | | 1.5 | 44 | 0.55 | | | | | | | | | | | 9.9 | 10 | | | | | |
| TS-SS-30 | | | | 5.4 | 310 | 6 | | | | | 5.2 | | | 7.4 | | | 8.3 | 13 | | | | | |
| TS-SS-31 | | | | 3.4 | 83 | 14 | | | | | | | | 5.7 | | | 64 | 3.9 | | | | | |
| TS-SS-32 | | | | 0.12 | 0.72 | 0.29 | 0.03 | 0.21 | 0.6 | 0.53 | 0.93 | | | 1.5 | | | 0.28 | 0.08 | | | | | |
| TS-SS-33 | | | | | 0.08 | 0.55 | 0.1 | 0.23 | 0.4 | 0.04 | 0.14 | | | 0.28 | | | 0.12 | | | | | | |
| TS-SS-34 | | | | | -0.05 | 1.9 | | | | | | | | | | | 0.8 | | | | | | |
| TS-SS-35 | | | | | 0.04 | 1.3 | | | | | | | | | | | 0.28 | | | | | | |
| TS-SS-36 | | | | | 0.2 | 0.38 | | | | | | | | | | | 0.02 | | | | | | |
| TS-SS-37 | | | | | 0.1 | 0.91 | | | | | | | | | | | 0.07 | | | | | | |
| TS-SS-38 | | | | | 0.84 | 1.94 | -0.03 | 0.18 | 0.8 | 0.3 | 0.4 | | | 0.14 | | | 0.48 | -0.08 | | | | | |
| TS-SS-39 | | | | | 0.87 | 5.1 | | | | | | | | | | | 0.48 | | | | | | |
| TS-SS-40 | | | | | 0.6 | 8 | | | | | | | | | | | 0.35 | | | | | | |
| TS-SS-41 | | | | | 0.47 | 8.3 | 0.46 | 0.5 | 1 | 0.47 | 0.82 | | | 0.58 | | | 0.28 | | | | | | |
| TS-SS-42 | | | | | 0.82 | 2 | | | 1 | 0.87 | 1.2 | | | 0.94 | | | 1.7 | 0.04 | | | | | |
| TS-SS-43 | | | | | 0.32 | 0.75 | | | | | | | | | | | 0.29 | | | | | | |
| TS-SS-44 | | | | | 0.38 | 9.1 | | | | | | | | | | | 0.23 | | | | | | |
| TS-SS-45 | | | | | 0.41 | 160 | | | | | | | | | | | 2.8 | 0.19 | | | | | |
| TS-SS-46 | | | | | 0.43 | 74 | | | | | | | | | | | 0.2 | | | | | | |
| TS-SS-47 | | | | | 0.23 | 13 | | | | | | | | | | | 0.31 | | | | | | |
| TS-SS-48 | | | | | 0.2 | 8.4 | | | 0.9 | 0.34 | 0.56 | | | 0.16 | | | 0.16 | | | | | | |
| TS-SS-49 | | | | | 0.44 | 8.3 | | | 0.7 | 0.13 | 0.41 | | | 0.18 | | | 0.24 | | | | | | |
| TS-SS-50 | | | | | -0.08 | 0.75 | | | | | | | | | | | 0.07 | | | | | | |
| TS-SS-51 | | | | | -0.09 | -0.05 | | | | | | | | | | | 0.91 | | | | | | |
| TS-SS-52 | | | | | 0.31 | 2.9 | | | | | | | | | | | 0.44 | | | | | | |
| TS-SS-53 | | | | | 0.46 | 1.4 | | | | | | | | | | | 0.41 | | | | | | |
| TS-SS-54 | | | | | 0.87 | 1.7 | 0.3 | 1 | 1.2 | 0.75 | 0.83 | | | 0.75 | | | 0.28 | | | | | | |
| TS-SS-55 | | | | | 33 | 5.6 | | | | | | | | | | | 6 | 47 | | | | | |
| TS-SS-56 | | | | | 1.5 | 0.14 | | | 4.8 | 1.3 | 4.8 | | | 0.28 | | | 1.1 | 15 | | | | | |

A.3

| | 01-90 | 02-90 | 03-90 | 04-90 | 06-90 | 07-90 | 08-90 | 09-90 | 10-90 | 11-90 | 12-90 | 01-91 | 02-91 | 03-91 | 04-91 | 05-91 | 06-91 | 07-91 | 08-91 | 09-91 | 10-91 | 11-91 | 12-91 |
|---------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Vegetation Samples | (pCi/mL) | | | | | | | | | | | | | | | | | | | | | | |
| TS-VG-01 | | | | 29 | 1.5 | 0.6 | 0.29 | 0.82 | 0.93 | | | | | | | | 0.27 | | 7.7 | | | | |
| TS-VG-02 | | | | 0.75 | 2.8 | 1.7 | | | | | | | | | | | 1.1 | | | | | | |
| TS-VG-03 | | | | 0.68 | 2.1 | 0.76 | | | | | | | | | | | 1.2 | | | | | | |
| TS-VG-04 | | | | 9 | 5.6 | 2.8 | | | | | | | | | | | 1.7 | | | | | | |
| TS-VG-05 | | | | | | | | | | | | | | | | | 2.1 | | | | | | |
| TS-VG-06 | | | | 0.45 | 3.5 | 1.2 | 7.7 | 1.4 | 11 | | | | | | | | 4.4 | | | | | | |
| TS-VG-07 | | | | | | | | | | | | | | | | | 0.69 | | | | | | |
| TS-VG-08 | | | | | | | | | | | | | | | | | 0.66 | | | | | | |
| TS-VG-09 | | | | | | | | | | | | | | | | | 0.87 | | | | | | |
| TS-VG-10 | | | | | | | | | | | | | | | | | 0.87 | | | | | | |
| TS-VG-11 | | | | | | | | | | | | | | | | | 1.2 | | | | | | |
| TS-VG-12 | | | | | | | | | | | | | | | | | 3.6 | | 22 | | | | |
| TS-VG-13 | | | | 11 | 100 | 110 | | | 100 | | | | | | | | 4.9 | | | | | | |
| TS-VG-14 | | | | 0.4 | 33 | 19.6 | | | | | | | | | | | 19 | | 32 | | | | |
| TS-VG-15 | | | | | | | | | | | | | | | | | 2.2 | | | | | | |
| TS-VG-16 | | | | | | | | | | | | | | | | | 0.8 | | | | | | |
| TS-VG-17 | | | | | | | | | | | | | | | | | 64 | | 245 | | | | |
| TS-VG-18 | | | | | | | | | | | | | | | | | 110 | | | | | | |
| TS-VG-19 | | | | 22 | 27 | 9.3 | | | | | | | | | | | 19 | | | | | | |
| TS-VG-20 | | | | 70.6 | 1 | 0.27 | | | | | | | | | | | 1.4 | | | | | | |
| TS-VG-21 | | | | | | | | | | | | | | | | | 0.14 | | | | | | |
| TS-VG-22 | | | | | | | | | | | | | | | | | 0.54 | | | | | | |
| TS-VG-23 | | | | | | | | | | | | | | | | | 0.82 | | | | | | |
| TS-VG-24 | | | | | | | | | | | | | | | | | 0.58 | | | | | | |
| TS-VG-25 | | | | 1600 | 0.34 | | 0.04 | -0.09 | 0.75 | | | | | | | | 0.41 | | | | | | |
| TS-VG-26 | | | | 1.3 | 270 | 72 | | | | | | | | | | | 61 | | 510 | | | | |
| TS-VG-27 | | | | 0.6 | 44 | 20 | | | | | | | | | | | 13 | | | | | | |
| TS-VG-28 | | | | 5.4 | 38 | 8.2 | | | | | | | | | | | 16 | | | | | | |
| TS-VG-29 | | | | | | | | | | | | | | | | | 6.8 | | 7.1 | | | | |
| TS-VG-30 | | | | | | | | | | | | | | | | | 12 | | 7.5 | | | | |
| TS-VG-31 | | | | 220 | | | | | | | | | | | | | 10 | | | | | | |
| TS-VG-32 | | | | 29 | 0.57 | 0.58 | 0.15 | 0.33 | 0.21 | | | | | | | | 0.38 | | 0.03 | | | | |
| TS-VG-33 | | | | | 0.14 | 0.18 | 0.11 | 0.22 | | | | | | | | | 0.08 | | | | | | |
| TS-VG-34 | | | | | | | | | | | | | | | | | 0.43 | | | | | | |
| TS-VG-35 | | | | | 0.19 | | | | | | | | | | | | 0.35 | | | | | | |

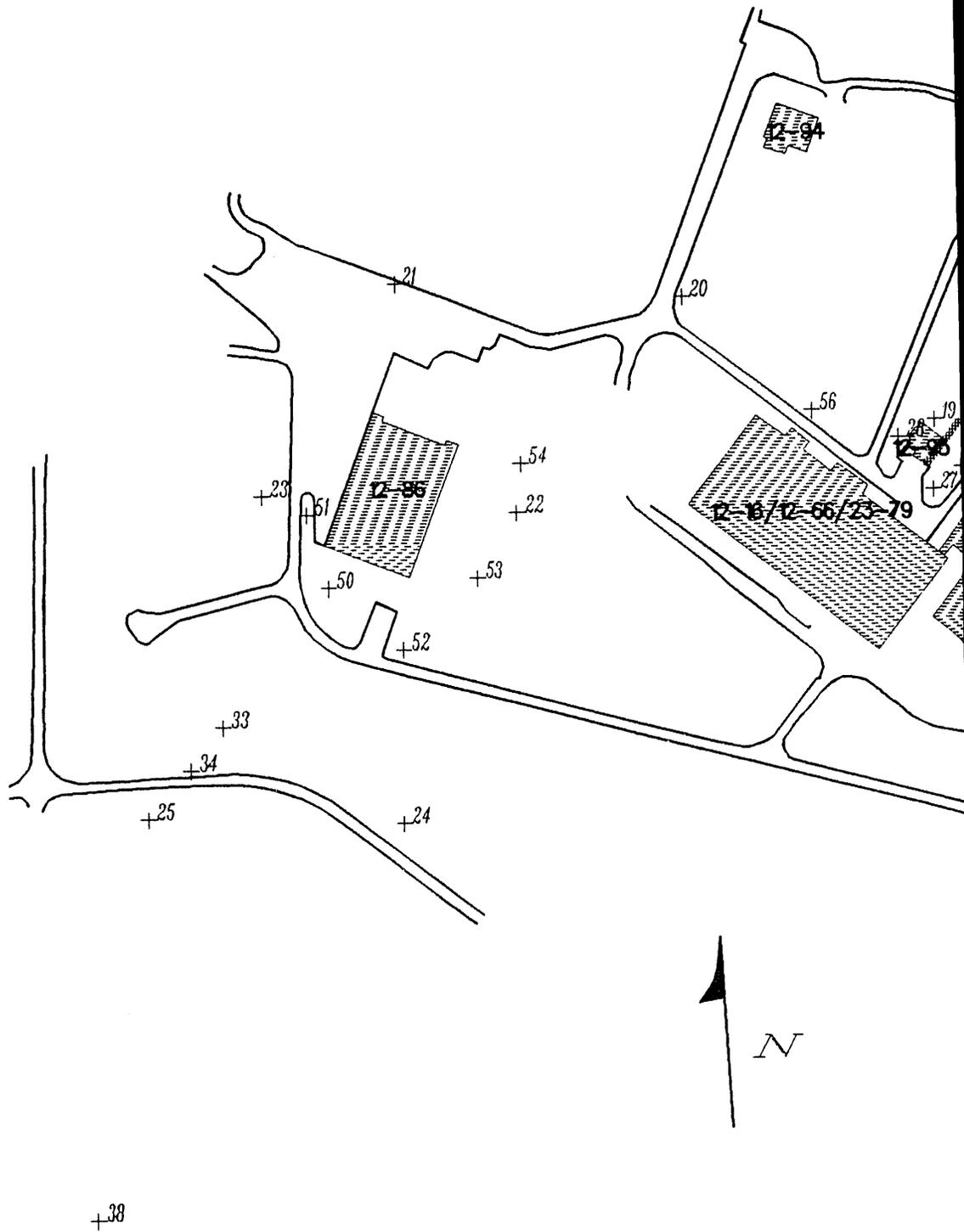
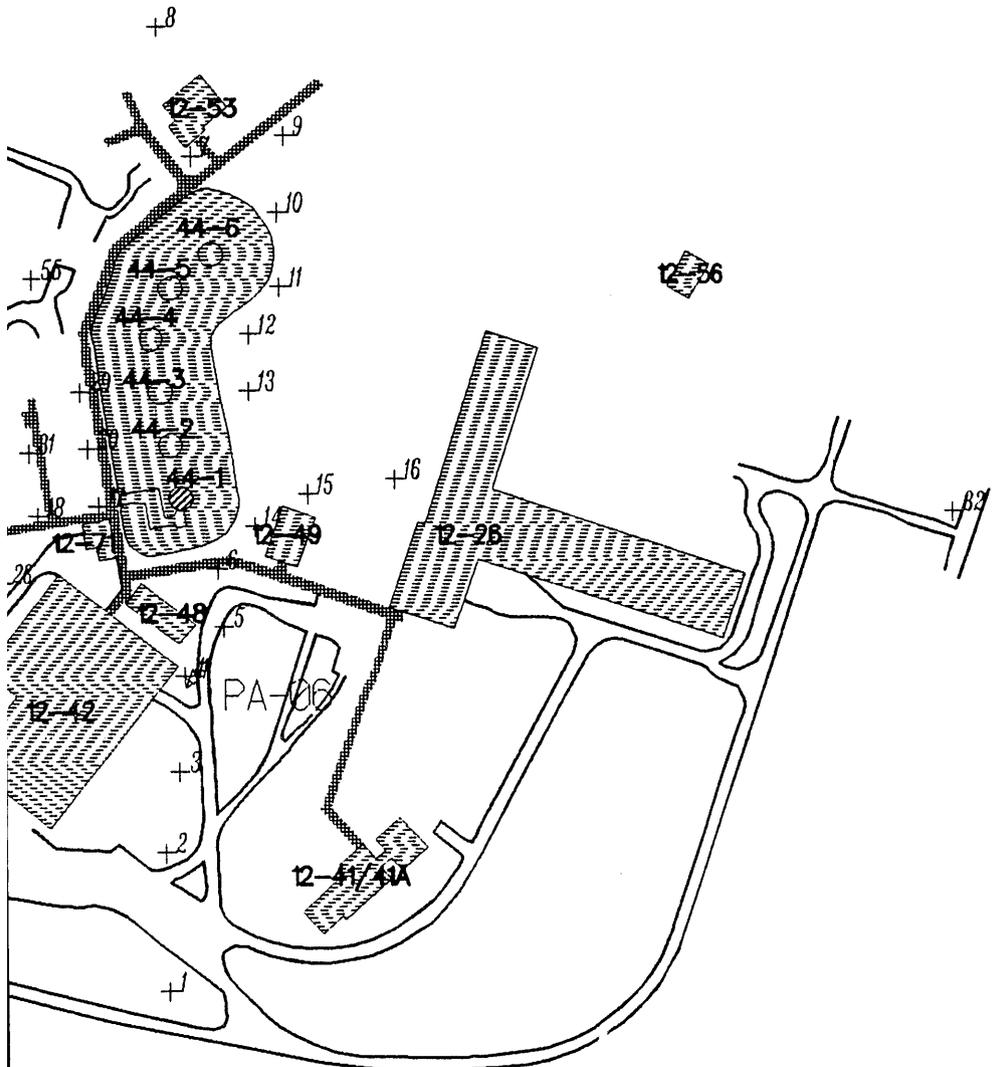


FIGURE A.1. Soil and Vegetation Sampling Points on Representational Map of Zone



-  Buildings (bold labels)
-  Cell 12-44-1 round room
-  Ramp
-  Roads
-  Soil and vegetation sampling points

12-South

APPENDIX B
GENII BASE-CASE OUTPUT FILE

GENII Dose Calculation Program
(Version 1.485 3-Dec-90)

Case title: Basecase for 1900 m ESE MEI dose calculation

Executed on: 10/08/93 at 10:16:47

Page A. 1

This is a near field (narrowly-focused, single site) scenario.
Release is chronic
Individual dose

THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:

Infinite plume, external
Inhalation uptake
Terrestrial foods ingestion
Animal product ingestion

THE FOLLOWING TIMES ARE USED:

Intake ends after (yr): 1.0
Dose calculations ends after (yr): 50.0

===== FILENAMES AND TITLES OF FILES/LIBRARIES USED=====

Input file name: \GENII\TRITR\SE\meibas\n.in
GENII Default Parameter Values (28-Mar-90 RAP)
Radionuclide Master Library (11/28/90 RAP)
Food Transfer Factor Library - (RAP 29-Aug-88) (UPDATED LEACHING FA
External Dose Factors in person Sv/yr per Bq/n (8-May-90 RAP)
Internal Dose Increments, Worst Case Solubilities, 12/3/90 PDR

=====

1 Surface soil input unit: (1-m2, 2-m3, 3-kg)

-----Basic Concentrations-----
Release Surface Deep Ground Surface
Radio- Air Soil Soil Water Water
nuclide Ci/m3 Ci/m2 Ci/m3 Ci/L Ci/L

H 3 1.0E+00 0.0E+00 0.0E+00 0.0E+00 0.0E+00

===== NEAR-FIELD PARAMETERS =====

0.0 Inventory disposed n years prior to beginning of intake period
0 LOIC occurred n years prior to beginning of intake period
1.0E+00 Fraction of roots in upper soil (top 15 cm)
0.0E+00 Fraction of roots in deep soil
0.0E+00 Manual redistribution: deep soil/surface soil dilution factor

===== EXTERNAL EXPOSURE =====

8.8E+03 Hours of exposure to plume

===== INHALATION =====

8.8E+03 Hours of inhalation exposure per year
1 Resuspension model: 1-Mass Loading, 2-Anspaugh
5.5E-05 Mass loading factor (g/m3)

===== TERRESTRIAL FOOD INGESTION =====

| FOOD TYPE | GROW TIME d | --IRRIGATION-- | | YIELD kg/m2 | PROD- UCTION kg/yr | --CONSUMPTION-- | |
|-----------|-------------|----------------|------------|-------------|--------------------|-----------------|------------|
| | | S RATE * in/yr | TIME mo/yr | | | HOLDUP d | RATE kg/yr |
| Leaf Veg | 90.0 | 0 | 0.0 | 1.5 | | 1.0 | 3.0E+01 |
| Oth. Veg | 90.0 | 0 | 0.0 | 4.0 | | 5.0 | 2.2E+02 |
| Fruit | 90.0 | 0 | 0.0 | 2.0 | | 5.0 | 3.3E+02 |

===== ANIMAL FOOD INGESTION =====

| FOOD TYPE | ---HUMAN--- | | TOTAL | DRINK | -----STORED FEED----- | | | | | |
|-----------|------------------------|----------|--------------------|---------------------|-----------------------|-------------|-----------------------------|------------|-------------|-------------|
| | CONSUMPTION RATE kg/yr | HOLDUP d | PROD- UCTION kg/yr | WATER CONTAM FRACT. | DIET FRAC- TION | GROW TIME d | -IRRIGATION- S RATE * in/yr | TIME mo/yr | YIELD kg/m3 | STOR- AGE d |
| Meat | 8.0E+01 | 5.0 | | 0.00 | 0.3 | 90.00 | 0 | 0.0 | 0.0 | 0.80 180.0 |
| Poultry | 1.8E+01 | 1.0 | | 0.00 | 1.0 | 90.00 | 0 | 0.0 | 0.0 | 0.80 180.0 |
| Meat | | | | | 0.75 | 45.0 | 0 | 0.0 | 0.0 | 2.00 100.0 |

=====

Input prepared by: _____ Date: _____

Input checked by: _____ Date: _____

=====

 GENII Dose Calculation Program
 (Version 1.485 3-Dec-90)

Case title: Baseline file for 1900 m ESE MEI dose calculation

Executed on: 10/08/93 at 10:16:53

Page C. 1

Uptake/exposure period: 1.0
 Dose commitment period: 50.0
 Dose units: Rem

| Organ | Committed Dose Equivalent | Weighting Factors | Weighted Dose Equivalent |
|------------------------------------|---------------------------|-------------------|--------------------------|
| Gonads | 5.7E+06 | 2.5E-01 | 1.4E+06 |
| Breast | 5.7E+06 | 1.5E-01 | 8.5E+05 |
| R Marrow | 7.0E+06 | 1.2E-01 | 8.4E+05 |
| Lung | 5.7E+06 | 1.2E-01 | 6.8E+05 |
| Thyroid | 5.7E+06 | 3.0E-02 | 1.7E+05 |
| Bone Sur | 6.7E+06 | 3.0E-02 | 2.0E+05 |
| Stomach | 5.7E+06 | 6.0E-02 | 3.4E+05 |
| S. Int. | 5.7E+06 | 6.0E-02 | 3.4E+05 |
| UL Int. | 5.7E+06 | 6.0E-02 | 3.4E+05 |
| LL Int. | 5.7E+06 | 6.0E-02 | 3.4E+05 |
| Internal Effective Dose Equivalent | | | 5.5E+06 |
| External Dose | | | 7.2E-04 |
| Annual Effective Dose Equivalent | | | 5.5E+06 |

 Controlling Organ: R Marrow
 Controlling Pathway: Ing
 Controlling Radionuclide: H 3

 Total Inhalation EDE: 7.7E+05
 Total Ingestion EDE: 4.8E+06

 GENII Dose Calculation Program
 (Version 1.485 3-Dec-90)

Case title: Baseline file for 1900 m ESE MEI dose calculation

Executed on: 10/08/93 at 10:16:53

Page C. 2

 Uptake/exposure period: 1.0
 Dose commitment period: 50.0
 Dose units: Rem

| | | Dose Commitment Year | | | | |
|----------|--------|---|---------|---------|---------|---|
| | | 1 | 2 | 3 | ... | |
| Internal | : | | | | | |
| Intake | : | | | | | |
| Year: | 3 | | 0.0E+00 | + | ... | |
| | 2 | | 0.0E+00 | + | 0.0E+00 | Internal |
| | 1 | 5.5E+06 | + | 0.0E+00 | + | 0.0E+00 |
| | | + ... = 5.5E+06 | | | | Effective Dose Equivalent |
| | | | | | | |
| Internal | Annual | 5.5E+06 + 0.0E+00 + 0.0E+00 + ... = 5.5E+06 | | | | Cumulative Internal Dose |
| Dose | | + | + | + | + | |
| External | Annual | 7.2E-04 | 0.0E+00 | 0.0E+00 | ... | 7.2E-04 |
| Dose | | | | | | |
| Annual | Dose | 5.5E+06 + 0.0E+00 + 0.0E+00 + ... = 5.5E+06 | | | | Cumulative Dose |
| | | | | | 5.5E+06 | Maximum Annual Dose Occurred In Year 1 |

 GENII Dose Calculation Program
 (Version 1.485 3-Dec-90)

Case title: Baseline file for 1900 m ESE MEI dose calculation

Executed on: 10/08/93 at 10:16:53

Page C. 3

 Uptake/exposure period: 1.0
 Dose commitment period: 50.0
 Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

| Pathway | Lung | Stomach | S Int. | UL Int. | LL Int. | Bone Su | R Marro | Testes |
|----------|---------|---------|---------|---------|---------|---------|---------|---------|
| Inhale | 7.9E+05 | 7.9E+05 | 7.9E+05 | 7.9E+05 | 7.9E+05 | 9.7E+05 | 9.7E+05 | 7.9E+05 |
| Leaf Veg | 2.1E+05 | 2.1E+05 | 2.1E+05 | 2.1E+05 | 2.1E+05 | 2.5E+05 | 2.6E+05 | 2.1E+05 |
| Oth. Veg | 1.6E+06 | 1.6E+06 | 1.6E+06 | 1.6E+06 | 1.6E+06 | 1.8E+06 | 1.9E+06 | 1.6E+06 |
| Fruit | 2.4E+06 | 2.4E+06 | 2.4E+06 | 2.4E+06 | 2.4E+06 | 2.8E+06 | 3.0E+06 | 2.4E+06 |
| Meat | 5.9E+05 | 5.9E+05 | 5.9E+05 | 5.9E+05 | 5.9E+05 | 7.0E+05 | 7.3E+05 | 5.9E+05 |
| Poultry | 1.3E+05 | 1.3E+05 | 1.3E+05 | 1.3E+05 | 1.3E+05 | 1.6E+05 | 1.6E+05 | 1.3E+05 |
| Total | 5.7E+06 | 5.7E+06 | 5.7E+06 | 5.7E+06 | 5.7E+06 | 6.7E+06 | 7.0E+06 | 5.7E+06 |

| Pathway | Ovaries | Muscle | Thyroid |
|----------|---------|---------|---------|
| Inhale | 7.9E+05 | 7.9E+05 | 7.9E+05 |
| Leaf Veg | 2.1E+05 | 2.1E+05 | 2.1E+05 |
| Oth. Veg | 1.6E+06 | 1.6E+06 | 1.6E+06 |
| Fruit | 2.4E+06 | 2.4E+06 | 2.4E+06 |
| Meat | 5.9E+05 | 5.9E+05 | 5.9E+05 |
| Poultry | 1.3E+05 | 1.3E+05 | 1.3E+05 |
| Total | 5.7E+06 | 5.7E+06 | 5.7E+06 |

External Dose by Exposure Pathway

| Pathway | |
|---------|---------|
| Plume | 7.2E-04 |
| Total | 7.2E-04 |

DISTRIBUTION

No. of
Copies

OFFSITE

- 12 DOE/Office of Scientific and Technical Information
- 36 D. A. McGrath
Mason & Hangar-Silas Mason, Co., Inc.
Pantex Plant
P.O. Box 30020
Amarillo, TX 79177

ONSITE

DOE Richland Operations Office

R. F. Brich, A5-55

21 Pacific Northwest Laboratory

S. T. Hwang, K6-52
T. A. Ikenberry, K3-54
W. E. Kennedy, Jr., K3-54
J. A. Mahaffey, P7-82
G. W. Patton, K6-16
S. F. Snyder (10), K3-54
Publishing Coordination
Technical Report Files (5)

DATE

FILMED

5/23/94

END

