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Prepared by
Oak Ridge Associated Universities

Prepared for
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U.S. Department of Energy

VERIFICATION SURVEY OF THE SHIPPINGPORT ATOMIC POWER STATION SHIPPINGPORT, PENNSYLVANIA

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Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
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VERIFICATION SURVEY
OF THE
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

INTRODUCTION

The Shippingport Atomic Power Station (SAPS) was the first large-scale, central station nuclear reactor in the United States. Plant operations began in 1957 under the direction of the U.S. Atomic Energy Commission; later the plant was operated by the Duquesne Light Company for the U.S. Department of Energy (successor to the Atomic Energy Commission). In October of 1982 the Shippingport Atomic Power Station was permanently shutdown, and the reactor core was removed in 1984. In September of 1984 the responsibility for decommissioning the station was assigned to the Surplus Facilities Management Program at the Department of Energy's Richland Operations Office.

The Richland Operations Office established the Shippingport Station Decommissioning Project, and selected General Electric (GE) as the decommissioning operations contractor, to accomplish this task. The purposes of this project were to demonstrate safe and cost effective dismantlement of a large scale nuclear power plant; increase the decommissioning technology base and experience through utilization of subcontractor organizations; and to promote technology transfer for applications in future projects.

It is the policy of the Department of Energy's Division of Facility and Site Decommissioning to perform independent (third party) verification of remedial activities. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established decontamination and decommissioning guidelines and that the documentation accurately and adequately describes the post-remedial action radiological conditions at the site. The Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities (ORAU) was designated by the DOE's Shippingport Station Decommissioning Project Office as the independent verification contractor for the SAPS Site. During the period remedial actions were being conducted, ORAU representatives performed independent measurements

and sampling at the SAPS Site. In addition, documents describing the project were reviewed, and selected remedial action samples were analyzed for comparison with GE's results. This report describes the procedures and findings of these verification activities.

FACILITY DESCRIPTION AND HISTORY

The SAPS Site is located in the Borough of Shippingport, Beaver County Pennsylvania, about 40 kilometers (25 miles) west of Pittsburgh (Figure 1). The site occupies approximately 3 hectares (7.5 acres) which is leased from the Duquesne Light Company by the U.S. Department of Energy. Figure 2 is a plot plan of the SAPS Site prior to decommissioning. The facility consisted of a 72-MWe pressurized water reactor and associated structures, fuel handling building with a 125 ton main crane and canal, radioactive waste treatment facilities, turbine building, test and training building, and administration building. These latter three structures are owned by Duquesne Light and were not dismantled during the decommissioning effort. The main components associated with the reactor were the reactor pressure vessel, which contained the fuel, and four primary coolant loops. The entire primary coolant system was enclosed in four 3.2 cm (1-1/4 inch) thick steel chambers. These steel chambers were inside concrete enclosures, with walls ranging in thickness from 1 to 2 meters (3 to 7 feet). The remaining large buildings were of concrete, reinforced concrete or brick construction. The radioactive waste treatment facilities consisted primarily of buried vaults and trenches.

SAPS was a joint project between the Federal Government and the Duquesne Light Company, the purposes of which were to demonstrate pressurized water reactor technology and to generate electricity. The reactor and steam generating portions of the project were owned by DOE, and the electrical generating portions by Duquesne Light. Duquesne Light operated the plant under the supervision of the DOE office of the Deputy Assistant Secretary for Naval Reactors. Criticality was achieved in 1957 and the reactor operated until 1982 during which time three cores of fuel were utilized. The first two cores were PWR cores and the last, installed in 1977, was a light water breeder reactor

core. The reactor was shutdown in October of 1982 at which time end-of-life testing and defueling was performed. GE began decommissioning the SAPS Site in 1984 and completed decommissioning in 1989.

PROCEDURES

Objectives

The objectives of the verification were to confirm that remedial actions have been effective in meeting established guidelines and that documentation accurately describes the post-remedial action radiological conditions of the site.

General

Verification activities were performed in accordance with Appendix I, Procedure for Independent Verification of Remedial Action and Correction of Discrepancies at Remote Sites and Vicinity Properties, of the Verification and Certification Protocol for Remote Sites Decontaminated under the Surplus Facilities Management Program, February 1986. Radiation exposure rates, contamination levels, radionuclide concentrations, etc., were determined from field and laboratory measurements, following procedures described in Survey Procedures Manual for the ORAU Environmental Survey and Site Assessment Program, and Quality Assurance Manual for the ORAU Environmental Survey and Site Assessment Program.

Procedures

The SAPS Site was divided into sections at the building or structure level so that packages could be prepared for release surveys which addressed a manageable portion of the facility. The release data packages[1], prepared by GE, contained the following information: definition of the area, release criteria (Appendix A), the radiological history of the area, and GE's release survey data. This package was submitted to DOE along with a request for independent verification.

Verification involved a combination of Type A and Type B reviews which are described in the February 1986 Verification and Certification document. Type A verifications primarily involve reviews of GE's data and analyses of split samples, while Type B verifications include onsite independent measurements and sampling and/or split sample analyses. Selection of the type of verification performed for a specific area was based on the history of use, radiological conditions before remedial action, applicable release limits, type of remedial action performed and post-remedial action radiological conditions. Although the scope of activities varied, depending on the type of verification selected for an area, all or some of the following activities were performed.

1. Professional level health physicists reviewed the release data packages for general thoroughness and accuracy. Data were evaluated to assure that areas exceeding guidelines were identified and had undergone remediation. Survey results were compared with guidelines to insure that the data had been interpreted correctly and that the guideline was appropriate.

2. Independent measurements and sampling were performed on portions of the area to be verified. Typically the independent survey covered 5 to 10% of the area to be verified. The actual fraction of the area selected for independent verification was package specific and was based on such factors as use history, radiological history, decontamination procedures, and post-remedial action survey data. During field activities, the scope of the survey was increased or decreased, based on findings as the work progressed. Instrumentation used for radiological measurements and sample analyses is given in Appendix B. Appendix C describes the measurement and analytical procedures.

   a. All survey activities were referenced to a grid system or prominent building features, whichever was used by GE.

   b. Surface scans of areas selected for independent verification were conducted to identify areas of residual contamination. Open land

areas were scanned for gamma radiation only; building surfaces and indoor areas were scanned for gamma and beta-gamma contamination. Verification surveys of excavations and below grade structures which were to remain intact were performed prior to backfilling. Up to 100% of the area selected for verification was scanned depending upon use and radiological history.

c. Gamma exposure rate measurements were performed at contact, 0.5 m, or 1.0 m, as appropriate for the applicable guideline.

d. Measurements for total beta-gamma and removable beta activity were performed on building surfaces to be left intact and materials to be sold for salvage. Measurement locations were randomly selected from the area or material being verified.

e. Samples of building material; residue from cracks, ledges, piping, ducts, and drains; and soil were collected. The number and location of samples was determined in the field, based on the availability of sample media and results of direct measurements. Additional samples were also collected from GE's archives for portions of the facility for which no or limited independent surveys or sampling were performed.

f. Following completion of verification activities performed for a given release package, survey results were compared with the applicable guidelines and a statement indicating the results of the verification activities was submitted to DOE by ORAU. If areas which exceeded the guidelines were identified, discrepancies were resolved prior to issuing a final statement of verification.

In addition to the onsite field activities described above, the following verification activities were also performed.

g. Samples of soil were collected from 16 locations in the Shippingport area to provide baseline concentrations of

radionuclides. Background exposure rates were measured at locations where baseline soil samples were collected.

h. The Final Consolidated Implementation Plan[2] and post-remedial action report[3] were reviewed for general thoroughness and accuracy.

i. Soil samples were selected from those collected by GE and analyzed for comparison with GE's results.

j. A representative number of soil samples were archived in accordance with Appendix II of the February 1986 Verification and Certification Protocol.

Sample Analysis and Interpretation of Results

Samples and direct measurement data were returned to Oak Ridge, Tennessee, for analyses and interpretation. Smears for the determination of removable contamination were counted for gross beta activity. Soil and miscellaneous samples were analyzed by solid state gamma spectrometry. Radionuclides of primary interest were Co-60, Cs-137, and Sb-125. Spectra were also reviewed for other identifiable photopeaks.

Measurement and analytical procedures are described in Appendix C. Observations and findings of the radiological surveys were compared to the DOE guidelines established for the SAPS site (Appendix A), as stated in the release package prepared by GE.

FINDINGS AND RESULTS

Document Review

The Final Consolidated Implementation Plan, release data packages and post-remedial action report[1-3] were reviewed. The Final Consolidated Implementation Plan adequately specified the limiting conditions to be met for

the SAPS site to be unconditionally released and accurately described the methodology for implementing the site release criteria. The release data packages indicated that decisions regarding requirements for remediation were appropriate and accurately described the remediation of these areas and the radiological status following completion of the remedial action. Scenarios were appropriately applied and stated and data presented demonstrated that remedial actions were effective in meeting the guidelines established for the specified area. Visual inspections confirmed that areas were demolished to the extent described in release data package. These packages have been consolidated to form the Site Release Record. The PRAR accurately summarizes the data from the Site Release Record which demonstrates that remedial actions were effective in meeting the guidelines established for the SAPS site.

Confirmatory Sample Analyses

Table 1 presents the results for gamma spectrometry analyses performed for 30 samples collected during remediation of the East and RWP Yard Trenches. All samples were prepared by GE for analyses and then sent by GE to ORAU for confirmatory analysis. A comparison of the results with a paired comparison t-test indicates that the difference between the two sets of measurements is not statistically significant ($p > 0.05$) for Co-60. A majority of the Cs-137 and Sb-125 concentrations were at or below the detection limits of the analytical procedure or had relatively large associated uncertainties; similar comparison methods are therefore not appropriate. However, for these radionuclides, paired data are in agreement within their respective 99% confidence intervals. It is, therefore, ORAU's opinion that the GE data are accurate and should be accepted as presented.

Background Measurements and Baseline Levels

Background measurements and baseline radionuclide concentrations in soil from the vicinity of the SAPS site are presented in Table 2. Exposure rates ranged from 8 to 13 μR/h at one meter from the surface. Cobalt-60 concentrations were <0.1 pCi/g; Cs-137 ranged from <0.1 pCi/g to 1.4 pCi/g; Sb-125 concentrations were less than or equal to 0.1 pCi/g.

Verification Surveys

The results of independent measurements are summarized in Tables 4-7. The tables are organized according to their release data package file number. These file numbers are associated with areas of the site which are identified in Table 3 and shown in Figure 4.

Table 4 summarizes the results of verification measurements for areas surveyed to the Residential, Occupancy and Exposed Slab scenarios. The values reported include contributions due to background (approximately 11 μR/h, see Table 2). This is only significant for those areas released to the Residential scenario applicable to material left within 3 meters of the surface. For comparison purposes the guideline is given at the top of Table 4 for each of the scenarios. The maximum measurement may exceed these values because the guidelines are given as average allowable levels and the release guidelines permit limited averaging of small isolated areas with exposure rates in excess of these values. To insure that areas were in compliance with the guideline when individual measurements exceeded the numeric limit, an Engineering Assessment was completed for inclusion with the data release package. All areas surveyed met the applicable guidelines. The Reactor Enclosure and Chamber was assessed independently and a supplemental limit was issued.[4] Supplemental limits are issued when the authorized limits (site specific guidelines) are not appropriate for a specific area or structure.[5]

Table 5 summarizes verification measurements for those items released to the Embedded Pipe scenarios. As mentioned previously, the guidelines are limits on the average level. Individual measurements may exceed the numerical limit as long as the average for the area demonstrated compliance with the applicable guideline. The Engineering Assessments prepared for such areas demonstrated that the average values are below the numerical limits and all embedded pipes surveyed met the applicable guidelines.

A summary of the radionuclide concentrations in soil is included as Table 6. Samples were taken during and following completion of the decommissioning activities. The guideline values are 6 pCi/g for soil in the

upper 3 meters and 100 pCi/g for soil below 3 meters. Fluctuations in localized concentrations are permitted if average concentrations are equal to or less than the limits. With the exception of the samples taken in April of 1989 for release data package A.12.3.25.1, the remaining samples were collected during the decommissioning process when these areas were accessible. Following completion of demolition activities, a reference grid was established on the SAPS site and 3 sampling areas identified which were used to establish sampling locations (Figure 5). Area I was composed of undisturbed soil, Area II had been excavated to 1 meter (the excavated soil was used as fill below 3 meters in Area III) and backfilled with clean fill, and Area III had been excavated to 3 meters and backfilled with clean fill. In Area I, composite surface soil samples were collected from each grid block. In Area II and the perimeter of Area I, subsurface samples (1-7 m) were either collected by ORAU during the GE drilling phase, or samples collected by GE were requested by and sent to ORAU for analysis. Area III was not sampled since the top 3 meters was clean fill and soil and concrete below 3 meters was surveyed prior to being relocated from Area II or during the verification of the release data packages for these areas. No areas with radionuclide concentrations in excess of the average guideline levels were identified. Exposure rates measured at 1 m above the surface at grid line intersections ranged from 8 to 13 μR/h, typical of background for this area (Table 2).

Structures to remain intact, or materials to be released for salvage were surveyed to the limits for mixed fission products specified in Regulatory Guide 1.86 which are summarized below:

Total Contamination

15,000 dpm/100cm^2 (maximum in a 100 cm^2 area)
5,000 dpm/100cm^2 (average over 1 m^2)

Removable Contamination

1,000 dpm/100 cm^2

Results of total and removable contamination measurements are summarized in Table 8.

All total and removable contamination levels were within these guidelines.

SUMMARY

During the period of February 1987 to April 1989, ORAU performed independent survey activities to verify the adequacy of remedial actions and supporting documentation for the decontamination and decommissioning of the Shippingport Atomic Power Station site in Shippingport, Pennsylvania. The verification activities included document reviews, independent direct measurements, and sample analyses. Based on the results and findings of these activities, it is ORAU's opinion that the remedial actions at the SAPS site in Shippingport, Pennsylvania have been effective in satisfying the established guidelines.

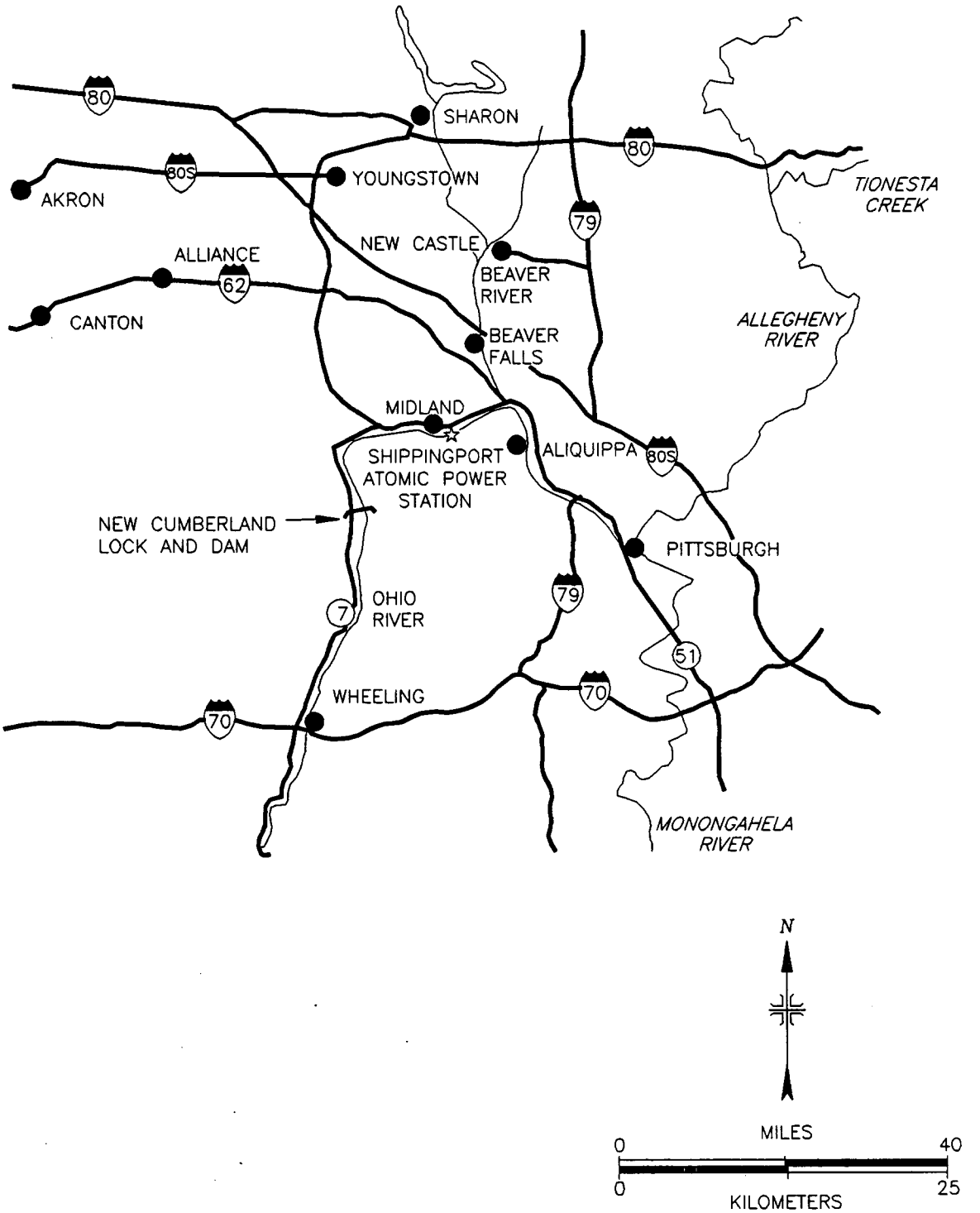
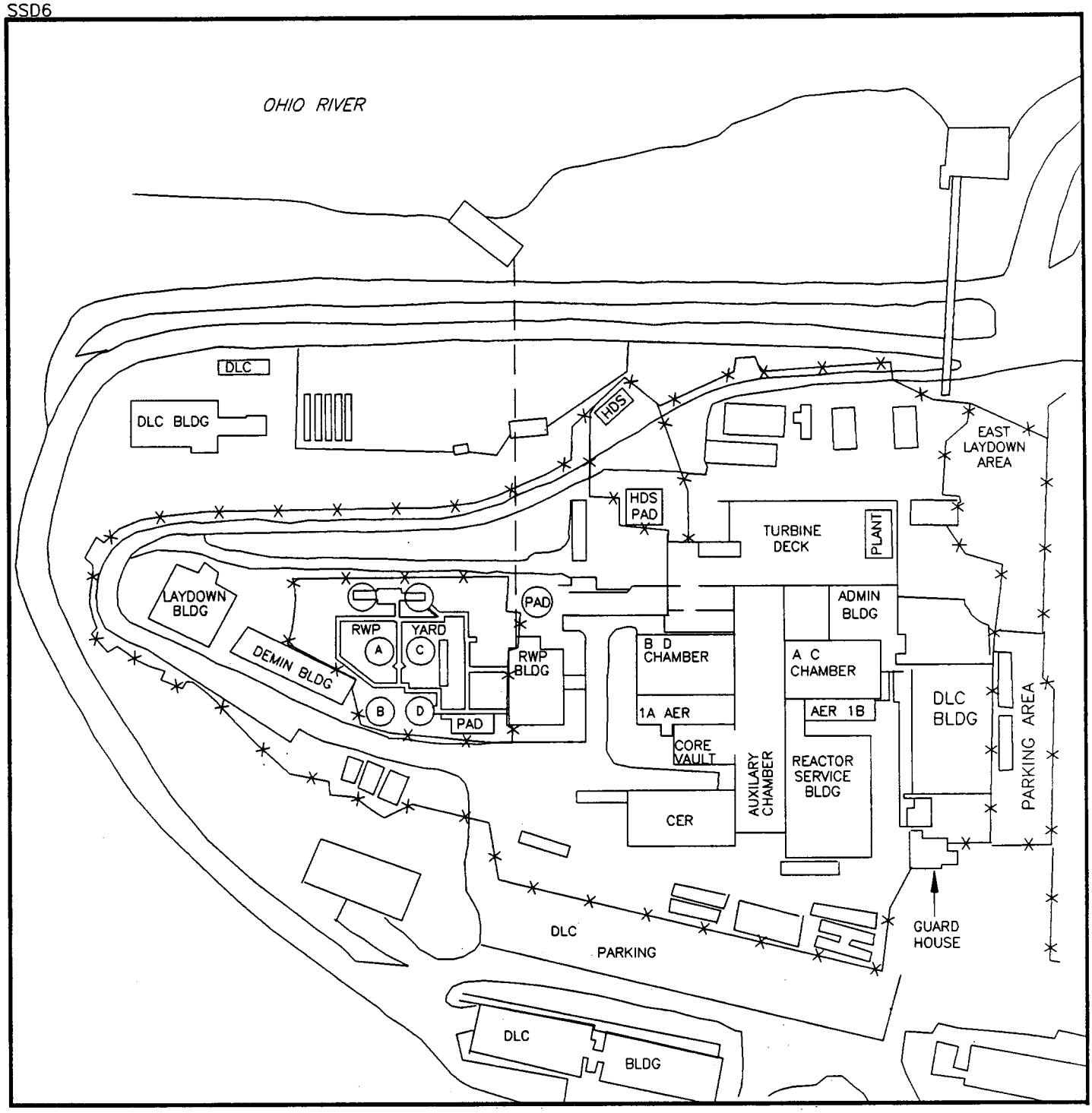


FIGURE 1: Map of Beaver County, Pennsylvania and Surrounding Area Indicating the Location of the Shippingport Atomic Power Station Site

SSD6



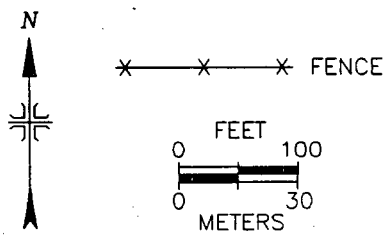


FIGURE 2: Plot Plan of the Shippingport Atomic Power Station Site

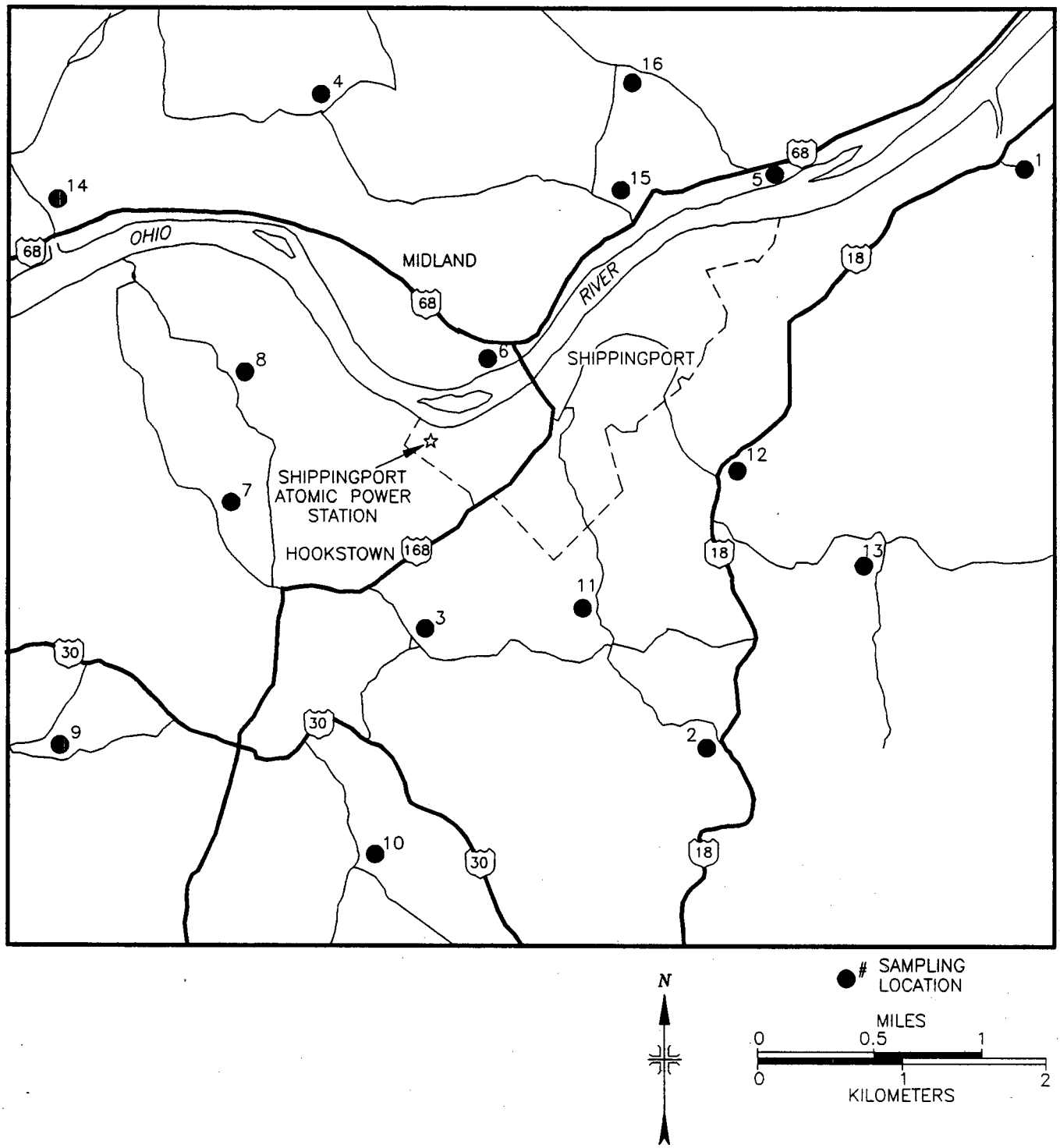


FIGURE 3: Map of Beaver County, Pennsylvania and Surrounding Area Showing Locations of Background Measurements and Baseline Samples

SSD6a

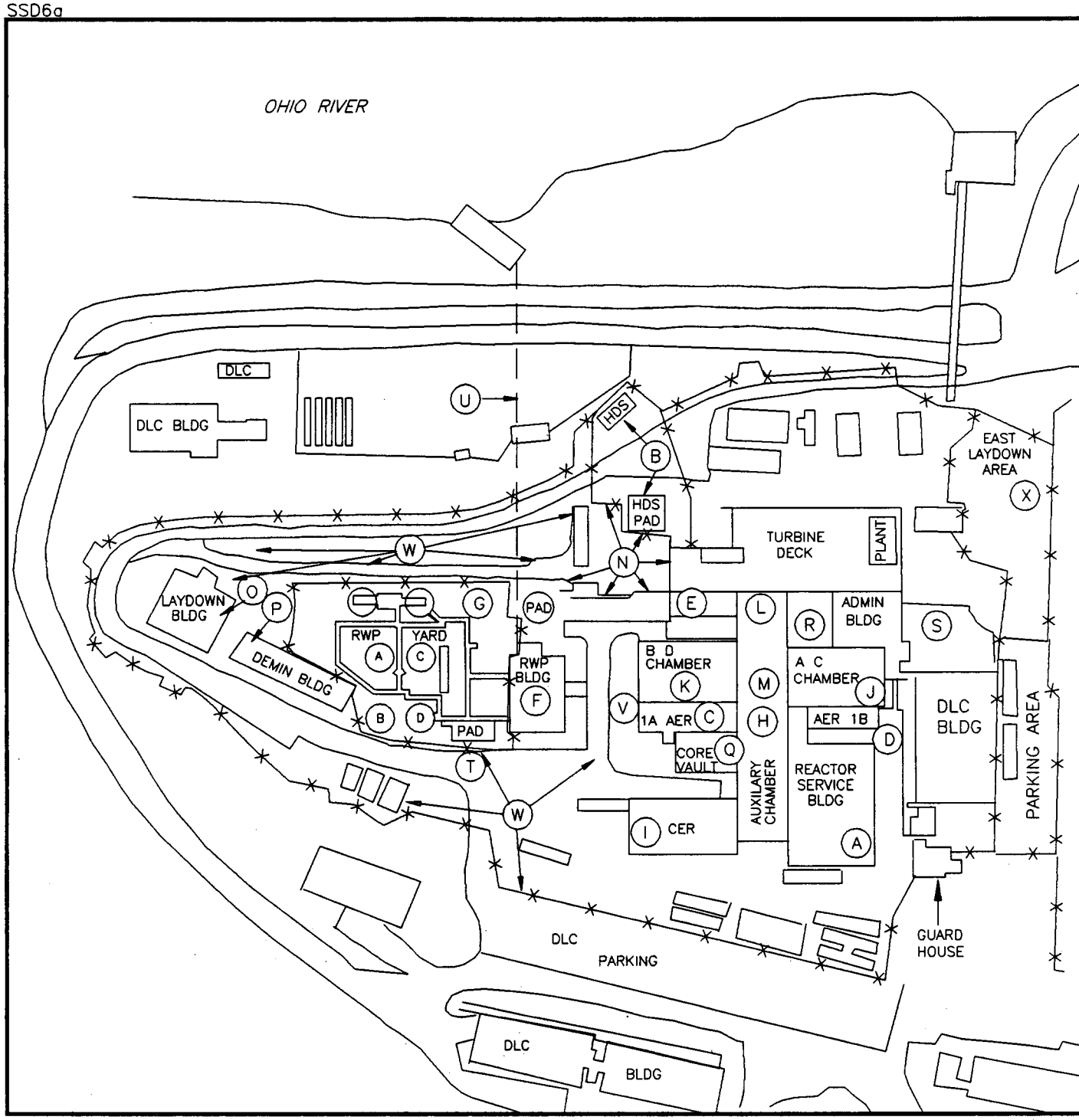


FIGURE 4: Plot Plan of the Shippingport Atomic Power Station Site Identifying Reference Areas

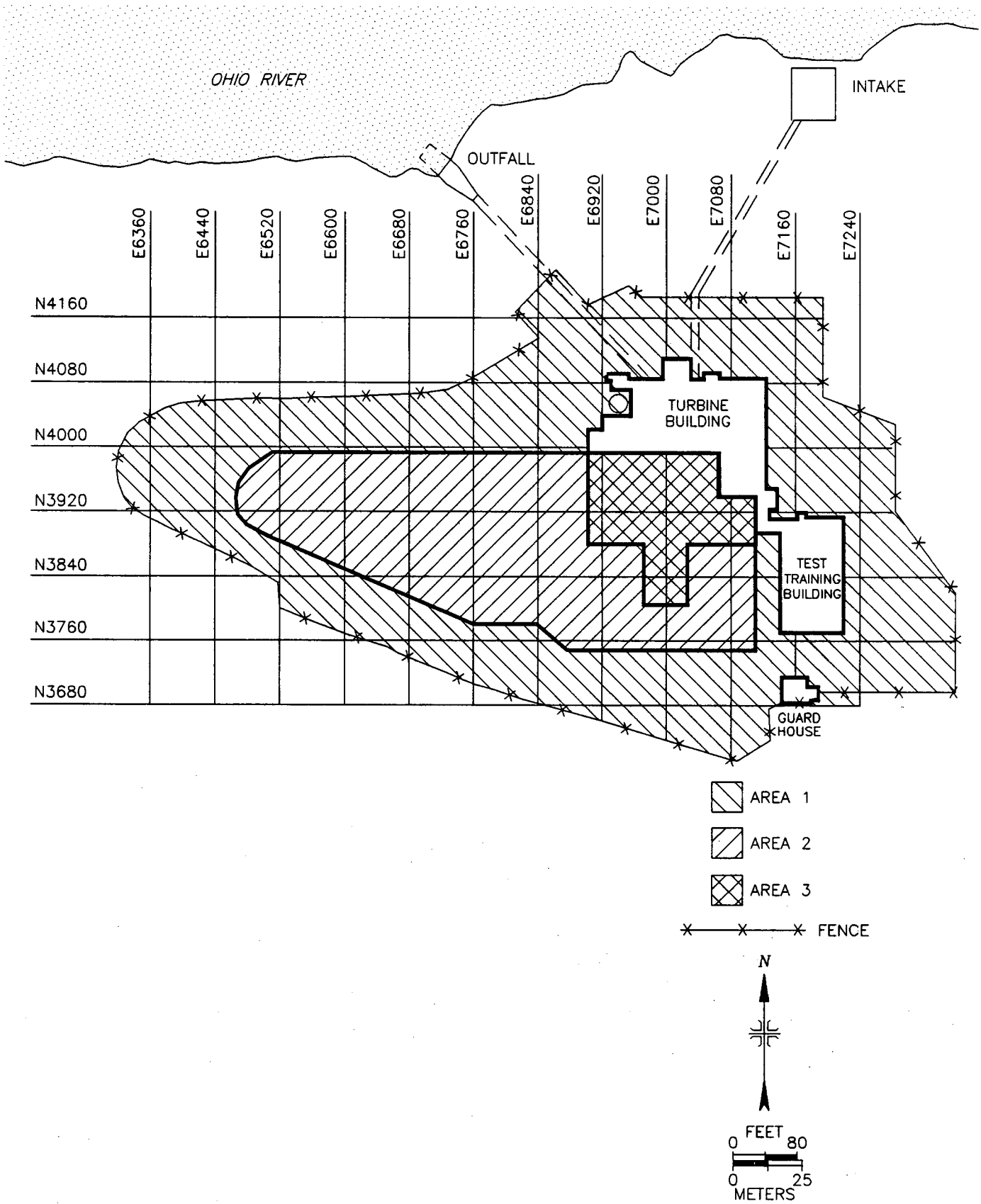


FIGURE 5: Plot Plan of the Shippingport Atomic Power Station Site Indicating the Reference Grid and Areas for Soil Sampling

TABLE 1

RESULTS OF CONFIRMATORY ANALYSIS OF SOIL SAMPLES
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Sample I.D.[a]	Analysis By	Radionuclide Concentrations (pCi/g)		
		Co-60	Cs-137	Sb-125
10-18-33	GE	1.6 ± 0.4[b]	1.2 ± 0.5	<MDA[c]
	ORAU	1.7 ± 0.3[d]	1.2 ± 0.2	<0.1
10-18-33	GE	1.9 ± 0.4	1.0 ± 0.6	<MDA
	ORAU	1.8 ± 0.4	1.5 ± 0.3	<0.1
EY-13-5	GE	0.2 ± 0.2	0.2 ± 0.2	0.2 ± 0.2
	ORAU	0.1 ± 0.2	0.1 ± 0.1	<0.1
EY-C-2	GE	0.3 ± 0.3	0.1 ± 0.1	0.3 ± 0.2
	ORAU	0.1 ± 0.2	0.1 ± 0.1	<0.1
EY-A-1	GE	0.4 ± 0.3	0.2 ± 0.2	<0.4
	ORAU	<0.1	0.2 ± 0.1	<0.1
EY-A-3	GE	0.2 ± 0.2	0.3 ± 0.2	0.2 ± 0.3
	ORAU	0.2 ± 0.2	<0.1	<0.1
EY-C-4	GE	0.2 ± 0.2	0.4 ± 0.3	0.4 ± 0.3
	ORAU	0.1 ± 0.1	0.4 ± 0.2	<0.1
EYN-3	GE	<0.3	<0.2	<0.3
	ORAU	<0.1	<0.1	<0.1
NES RWP-1	GE	<0.3	0.2 ± 0.1	<0.2
	ORAU	0.1 ± 0.2	<0.1	<0.1
NES RWP-3	GE	0.5 ± 0.4	1.2 ± 0.5	<0.3
	ORAU	0.4 ± 0.2	1.3 ± 0.3	<0.1
NES RWP-4	GE	0.2 ± 0.2	0.3 ± 0.2	<0.3
	ORAU	0.1 ± 0.1	0.2 ± 0.1	<0.1
NES RWP-6	GE	0.5 ± 0.4	1.3 ± 0.5	<0.5
	ORAU	0.3 ± 0.3	1.0 ± 0.2	<0.1
NEW RWP-7	GE	<0.2	0.2 ± 0.2	0.3 ± 0.2
	ORAU	<0.1	0.1 ± 0.2	<0.1
B/D Enclosure Trench	GE	48 ±16	2.9 ± 2.9	8.7 ± 5.3
	ORAU	41.5 ± 3.6	0.3 ± 0.7	14.1 ± 3.1

TABLE 1 (continued)

RESULTS OF CONFIRMATORY ANALYSIS OF SOIL SAMPLES
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Sample I.D.[a]	Analysis By	Radionuclide Concentrations (pCi/g)		
		Co-60	Cs-137	Sb-125
B/D Trench 5	GE	11 ± 7	<2.6	<2.8
	ORAU	8.2 ± 1.8	1.0 ± .9	<0.5
Trench 8	GE	13 ± 9	<2.0	<3.8
	ORAU	20.7 ± 3.5	0.7 ± 1.1	<0.9
Trench 10	GE	21 ± 9	2 ± 2	<2.8
	ORAU	24.2 ± 2.9	1.1 ± 1.1	<0.6
Trench 10	GE	27 ±11	4.5 ± 2.9	80 ±19
	ORAU	29.5 ± 3.4	6.0 ± 1.3	130 ±10
Trench 10	GE	40 ±15	30 ±10	34 ±11
	ORAU	45.9 ± 4.5	28.9 ± 3.0	49.5 ± 6.3
B/D Trench 11	GE	19 ± 9	3.4 ± 2.9	4.8 ± 4.4
	ORAU	17.3 ± 2.7	1.7 ± 0.8	<0.8
B/D Trench 13	GE	15 ±10	<3.2	<2.9
	ORAU	12.5 ± 2.0	0.9 ± 0.7	<0.6
1AMER #5	GE	4.2 ± 4.7	2.6 ± 2.9	<4.3
	ORAU	5.0 ± 2.0	0.9 ± 0.8	<0.8
East Yard By Pipe Support	GE	0.3 ± 0.3	0.3 ± 0.2	<0.3
	ORAU	0.1 ± 0.2	0.3 ± 0.2	<0.1
East Yard Vent to SIS	GE	<0.2	<0.3	<0.2
	ORAU	<0.1	<0.1	<0.1
East Yard Valve Pit	GE	0.2 ± 0.2	0.5 ± 0.3	<0.5
	ORAU	0.2 ± 0.1	0.4 ± 0.2	<0.1
East Yard Valve Pit	GE	<0.2	0.1 ± 0.1	<0.3
	ORAU	<0.1	0.1 ± 0.1	<0.1
Gravel Pit Concrete	GE	168 ±29	20 ±15	39 ±14
	ORAU	130 ±10	16.3 ± 2.5	18.3 ± 5.1
Hot Chem Lab #1 Concrete	GE	<6.5	<3.0	<1.7
	ORAU	<0.4	<0.2	<0.5

TABLE 1 (continued)

RESULTS OF CONFIRMATORY ANALYSIS OF SOIL SAMPLES
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Sample I.D.[a]	Analysis By	Radionuclide Concentrations (pCi/g)		
		Co-60	Cs-137	Sb-125
Hot Chem Lab	GE	17 ± 9	14 ± 7	1.9 ± 2.3
#2 Concrete	ORAU	12.5 ± 2.2	13.2 ± 2.0	<0.8
Hot Chem Lab	GE	33 ±12	9.8 ± 5.1	<4.8
#3 Concrete	ORAU	23.3 ± 3.0	5.5 ± 1.2	<0.7

[a]Sample identification as provided by GE.
[b]GE uncertainties represent the 99% confidence levels.
[c]Reported as less than the minimum detectable activity; no value given.
[d]ORAU uncertainties represent the 99% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 2

BACKGROUND EXPOSURE RATES
AND
BASELINE RADIONUCLIDE CONCENTRATIONS IN SOIL
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Location[a]	Exposure Rate At 1 m Above The Surface (μR/h)	Radionuclide Concentrations (pCi/g)		
		Co-60	Cs-137	Sb-125
1	11	<0.1	0.1 ± 0.1[b]	<0.1
2	13	<0.1	0.5 ± 0.2	<0.1
3	12	<0.1	0.1 ± 0.1	<0.1
4	12	<0.1	0.8 ± 0.2	<0.1
5	10	<0.1	1.0 ± 0.2	<0.1
6	11	<0.1	0.1 ± 0.1	<0.1
7	11	<0.1	0.1 ± 0.1	<0.1
8	11	<0.1	0.2 ± 0.1	<0.1
9	10	<0.1	<0.1	<0.1
10	10	<0.1	0.2 ± 0.1	<0.1
11	12	<0.1	0.3 ± 0.1	<0.1
12	11	<0.1	0.2 ± 0.1	<0.1
13	12	<0.1	<0.1	0.1 ± 0.3
14	8	<0.1	0.7 ± 0.1	<0.2
15	9	<0.1	0.2 ± 0.1	<0.1
16	10	<0.1	1.4 ± 0.2	<0.1

[a]Refer to Figure 3.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 3

KEY TO REFERENCE REGIONS AND FILE NUMBERS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Identification[a]	Area	File Number
A	Reactor Service Building	A.12.3.2
B	Heat Dissipation System	A.12.3.3
C	1A-Auxiliary Equipment Room	A.12.3.4
D	1B-Auxiliary Equipment Room	A.12.3.5
E	Air Treatment Room	A.12.3.6
F	RWP Building	A.12.3.7
G	RWP Yard	A.12.3.8
H	Fuel Handling Building	A.12.3.9
I	Contaminated Equipment Room	A.12.3.10
J	A/C Chamber & Enclosure	A.12.3.12
K	B/D Chamber & Enclosure	A.12.3.13
L	Auxiliary Chamber & Enclosure	A.12.3.14
M	Reactor Enclosure & Chamber	A.12.3.15
N	Exposed Surfaces	A.12.3.16
O	Laydown Building	A.12.3.17
P	Demineralizer Building	A.12.3.18
Q	Core Vault	A.12.3.19
R	Aux Power Room & Admin Bldg.	A.12.3.20

TABLE 3 (Continued)

KEY TO REFERENCE REGIONS AND FILE NUMBERS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

Identification[a]	Area	File Number
S	Aux Control Room	A.12.3.21
T	Enclosure Shield Plugs (Various Locations)	A.12.3.22
U	Effluent Header	A.12.3.23
V	Tank Foundations & Trenches (East Yard)	A.12.3.24
W	Site Soil	A.12.3.25

[a]Refer to Figure 4.

TABLE 4

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.2.2	REACTOR SERVICE BUILDING - AREA 2, RADIOCHEMISTRY, HOT LABORATORY, WOMEN'S TOILET, CONTAMINATED WASHROOM CONTAMINATED LOCKER ROOM AND SHOWER	RE-ALL	12/87		9- 26			
A.12.3.2.3	REACTOR SERVICE BUILDING - AREA 7, SAMPLE PREPARATION ROOM	RE-ALL	11/87		9-130			
A.12.3.2.4	REACTOR SERVICE BUILDING - AREA 8, CONTAMINATED INSTRUMENT SHOP	RE-ALL	10/87		9- 21			
A.12.3.2.5	REACTOR SERVICE BUILDING - AREA 5, REACTOR PLANT LAUNDRY, LOCKER ROOM, MEN'S TOILET, OUTSIDE WALLS, AND HEALTH PHYSICS LABORATORY	RE-CONCRETE WALLS AND FLOORS AND TRENCH WALLS ABOVE 738'	12/87		6- 26			
		ES-TRENCH FLOOR (BELOW 738')						14- 80 @ CONTACT
A.12.3.2.6	REACTOR SERVICE BUILDING - AREA 4, MONITORED WASTE ROOM, ASSEMBLY ROOM, LUNCH ROOM, AND SOUTH HALLWAY	RE-CONCRETE WALLS AND FLOORS OF ASSEMBLY ROOM, LUNCH ROOM AND SOUTH HALLWAY, TRENCH COVERS AND WALLS	12/87		7- 10			
		ES-TRENCH FLOOR	12/87					16- 21 @ CONTACT
		OC-MONITORED WASTE ROOM	12/87			9- 33		

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 μR/h @ CONTACT	900 μR/h @ CONTACT	200 μR/h @ CONTACT	50 μR/h @ 1 m	600 μR/h @ 0.5 m
A.12.3.2.7	REACTOR SERVICE BUILDING - AREA 9, 1A - MECHANICAL EQUIPMENT ROOM	RE-ALL	12/87		11- 14			
A.12.3.2.8	REACTOR SERVICE BUILDING - AREA 1, COLD CHEMISTRY LAB AND CHEMISTRY CALCULATION ROOM	RE-ALL	11/87		9- 11			
A.12.3.2.9	REACTOR SERVICE BUILDING - AREA 3, WORKSPACE, DARKROOM, AND RADIATION AND CHEMISTRY COUNTING ROOM	RE-ALL	12/87		8- 11			
A.12.3.2.11	REACTOR SERVICE BUILDING - AREA 6, RADCON FIELD OFFICE, RAIL PLATFORM, AND HALLWAY	RE-ALL	12/87		11- 26			
A.12.3.3.1	HEAT DISSIPATION SYSTEM[a]	RE-PUMPHOUSE PAD, ALL PIERS & FOUNDATIONS, AND THE MANHOLE AND PUMP SUCTION BAY ABOVE 703'	12/87, 2/88	7- 21				
		ES-MANHOLE BELOW 703'	12/87					7- 14 @ CONTACT
		CC-PUMP SUCTION BAY BELOW 703'	12/87			7- 14		
A.12.3.4.1	1A AUXILIARY EQUIPMENT ROOM[a]	RE-CONCRETE WALLS AND FLOOR AND CONCRETE BLOCK AROUND DEMINERALIZER PIT	8/87, 10/87, 1/88		16-250			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 μR/h @ CONTACT	900 μR/h @ CONTACT	200 μR/h @ CONTACT	50 μR/h @ 1 m	600 μR/h @ 0.5 m
A.12.3.5.1	1B AUXILIARY EQUIPMENT ROOM[a]	RE-BOTTLED GAS STORAGE AREA CONCRETE PAD EAST, WEST, AND SOUTH WALLS OF AER 1B AND FLOOR, CONCRETE EAST, WEST AND SOUTH WALLS AND FLOOR OF AER 1B, TRENCH AND SUMP OF AER 1B ABOVE 732'	9/87, 4/88		11- 16			
		ES-SUMP AND TRENCH CONCRETE BELOW 732'	12/87					11- 85 @ CONTACT
A.12.3.6.1	AIR TREATMENT ROOM	RE-ALL	11/87		9- 60			
A.12.3.7.2	RWP BUILDING - CONDITIONALLY CLEAN SURFACES, BUILDING EXTERIOR	RE-CONCRETE ROOF AND WALLS ABOVE 732'	9/88		9- 21			
A.12.3.7.3	RWP BUILDING - CONDITIONALLY CLEAN SURFACES, BUILDING INTERIOR	RE-CONCRETE CEILING AND WALLS ABOVE 732'	9/88		7-250			
A.12.3.7.4	RWP BUILDING - CLEAN SURFACES, BUILDING INTERIOR	RE-CONCRETE INTERIOR WALLS AND FLOORS, THE INSIDES OF THE EXTERIOR WALLS IN RWP BUILDING AREA 1 THROUGH 6, 11, AND 15 BETWEEN 741' & 735', THE EXPOSED OUTSIDE ROOF OF THE EVAPORATOR ROOM AND THE ABOVE GROUND PORTION OF THE STACK FOUNDATION	9/88		6-400			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 μR/h @ CONTACT	900 μR/h @ CONTACT	200 μR/h @ CONTACT	50 μR/h @ 1 m	600 μR/h @ 0.5 m
A.12.3.7.5	RWP BUILDING - SUSPECT SURFACES, BUILDING INTERIOR[a]	RE-CONCRETE WALLS, FLOORS, AND CEILINGS BETWEEN 735' and 732' IN AREAS 3, 4, AND 5 AND CEILING OF THE TRENCH	9/88		9- 90			
		ES-CONCRETE WALLS AND FLOOR OF THE PIT IN AREA 3, WALLS UNDER STACK FOUNDATION, AND WALLS AND FLOOR OF TRENCH, BELOW 732'	9/88					9- 14 @ CONTACT
		.28 μR/h-RUBBLED CONCRETE IN AREA 8	9/88		9- 16			
A.12.3.7.6	RWP BUILDING - CONTAMINATED SURFACES BUILDING INTERIOR	RE-CONCRETE WALLS AND FLOORS IN AREAS 2, 6, & 11 BETWEEN 732' and 735' AND WALLS AND FLOORS IN AREA 9 BETWEEN 732' and 741'	9/88		9-300			
		ES-CONCRETE WALLS AND FLOORS IN AREAS 2, 6, 9, & 11 BELOW 732'	9/88					9-250 @ CONTACT
A.12.3.7.7	RWP BUILDING - COOLING TOWER FOUNDATIONS	RE-ALL	4/88		12- 13			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 µR/h @ CONTACT	900 µR/h @ CONTACT	200 µR/h @ CONTACT	50 µR/h @ 1 m	600 µR/h @ 0.5 m
A.12.3.7.8	RWP BUILDING - STAIRWELL, BASEMENT, AND EVAPORATOR ROOM	RE-CONCRETE CEILINGS AND WALLS ABOVE 732', WALLS & FLOORS OF BASEMENT SUMP & EVAPORATOR ROOM BELOW 725' AND PENETRATIONS	9/88		7-130			
		ES-CONCRETE WALLS AND FLOORS OF STAIRWELL BELOW 732' AND WALLS OF EVAPORATOR ROOM BETWEEN 732' & 725'	9/88					10- 21 @ CONTACT
		OC-CONCRETE WALLS & FLOORS (EXCLUDING SUMP) OF BASEMENT BELOW 732'	9/88			9- 21		
A.12.3.8.2	RWP YARD - AREA 2, RESIN TANK 1A, ENCLOSURE AND VALVE PIT	RE-CONCRETE IN VALVE PIT BELOW 725', ENCLOSURE CEILING, INSTRUMENT HOUSE FOUNDATION, AND SHAFTS TO RESIN TANK ENCLOSURES, AND THE ELECTRICAL HOLE	6/88		16- 21			
		ES-CONCRETE WALLS IN VALVE PIT BETWEEN 732' AND 725'	6/88					9- 14 @ CONTACT
		OC-CONCRETE WALLS & FLOOR IN RESIN TANK ENCLOSURE	6/88			16- 85	19	
A.12.3.8.3	RWP YARD - AREA 3, RESIN TANK 1B ENCLOSURE & VALVE PIT	RE-CONCRETE SHAFTS WHICH LEAD TO THE RESIN TANK ENCLOSURE, THE ENCLOSURE CEILING, THE INSTRUMENT HOUSE FOUNDATION, ELECTRICAL HAND HOLE, TOP 3' OF VALVE PIT, THE VALVE PIT FLOOR, & VALVE PIT WALLS BELOW 725'	6/88		9- 26			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 µR/h @ CONTACT	900 µR/h @ CONTACT	200 µR/h @ CONTACT	50 µR/h @ 1 m	600 µR/h @ 0.5 m
A.12.3.8.3 CONTINUED	RWP YARD - AREA 3, RESIN TANK 1B ENCLOSURE & VALVE PIT	ES-VALVE PIT WALLS BETWEEN 725' & 732'	6/88					9- 14 @ CONTACT
		OC-RESIN TANK FLOOR & WALLS	6/88			11- 75	16	
A.12.3.8.4	RWP YARD - AREA 4, SURGE TANK A ENCLOSURE	RE-PUMP PIT WALL & FLOOR, THE ENCLOSURE ROOF, INSTRUMENT HOUSE FOUNDATION, AND ENCLOSURE WALLS DOWN TO 732'	6/88		11-350			
		OC-ENCLOSURE WALLS & FLOOR BELOW 732'	6/88			11-150	21- 31	
A.12.3.8.5	RWP YARD - AREA 5, SURGE TANK B ENCLOSURE	RE-PUMP PIT WEST WALL & FLOOR, ENCLOSURE ROOF, INSTRUMENT HOUSE FOUNDATION, AND ENCLOSURE WALLS DOWN TO 732'	8/88		6-250			
		OC-ENCLOSURE WALLS BELOW 732'				6- 38		
A.12.3.8.6	RWP YARD - AREA 6, SURGE TANK C ENCLOSURE	RE-PUMP PIT WALL AND FLOOR, ENCLOSURE ROOF, INSTRUMENT HOUSE FOUNDATION, AND ENCLOSURE WALLS DOWN TO 732'	6/88		11-300			
		OC-ENCLOSURE WALLS AND FLOOR BELOW 732'				16-300	26- 31	
A.12.3.8.7	RWP YARD - AREA 7, SURGE TANK D ENCLOSURE	RE-PUMP PIT WEST WALL AND FLOOR, ENCLOSURE ROOF, INSTRUMENT HOUSE FOUNDATON, AND ENCLOSURE WALLS DOWN TO 732'	8/88		8-390			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 R/h @ CONTACT	RESIDENTIAL 900 R/h @ CONTACT	OCCUPANCY 200 R/h @ CONTACT	OCCUPANCY 50 R/h @ 1 m	EXPOSED SLAB 600 R/h @ 0.5 m
A.12.3.8.7 CONTINUED	RWP YARD - AREA 7, SURGE TANK D ENCLOSURE	OC-ENCLOSURE WALLS BELOW 732'	8/88			9- 75	36	
A.12.3.8.8	RWP YARD - AREA 8, CONDENSER PIT	RE-CONCRETE IN PIT ABOVE 732'	7/88	9- 19				
		RE-CONCRETE SHIELD PLUGS AND PRECAST COVERS AND REMAINING CONCRETE IN PIT BELOW 725'			9- 43			
		S-CONCRETE IN PIT BETWEEN 725' AND 732'						9- 21 @ CONTACT
A.12.3.8.9	RWP YARD - AREA 9, ELECTRICAL STRUCTURES	RE-THE DUCT BANKS BETWEEN 725' AND 732'	8/88	11- 16				
		RE-CONCRETE OF ELECTRIC MANHOLES, DUCT BANKS, AND LIGHTPOLE FOUNDATIONS ABOVE 732'			9- 21			
		ES-CONCRETE IN THE MANHOLES AND HAND HOLE ASSOCIATED WITH AREA 9C BELOW 732'	8/88					9- 16 @ CONTACT
A.12.3.8.10	RWP YARD - AREA 10, TANK & SHED FOUNDATIONS	RE-CONCRETE ABOVE 732', INCLUDES PORTIONS OF AREAS A, B, D, E, H AND I-L, AND ALL OF AREAS C, F, AND G	7/88, 9/88		9- 55			
		ES-CONCRETE BELOW 732'	7/88					
A.12.3.8.11	RWP YARD - AREA 11, EFFLUENT STRAINER PIT, MANHOLE, AND SAMPLE BUILDING	RE-EFFLUENT STRAINER PIT AND MANHOLE CONCRETE ABOVE 732', ALL OF SAMPLE BUILDING, AND MANHOLE WALLS AND FLOOR BELOW 725'	6/88		10- 50			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 μR/h @ CONTACT	900 μR/h @ CONTACT	200 μR/h @ CONTACT	50 μR/h @ 1 m	600 μR/h @ 0.5 m
A.12.3.8.11 CONTINUED	RWP YARD - AREA 11, EFFLUENT STRAINER PIT, MANHOLE, AND SAMPLE BUILDING	ES-EFFLUENT STRAINER PIT AND MANHOLE CONCRETE BETWEEN 732' & 725'	6/88					11- 41 @ CONTACT
A.12.3.8.12	RWP YARD - AREA 12, ION EXCHANGER ENCLOSURE[b]	RE-ROOF OF ION EXCHANGER ENCLOSURE, WALLS AND CEILING OF PIPE GALLERY AND WALLS OF VAULTS ABOVE 732'	9/88	11- 16				
		RE-WALLS OF ION EXCHANGER ENCLOSURE VAULTS BELOW 725' AND FLOORS OF THE VAULTS & THE PENETRATIONS (NOT TREATED AS EMBEDDED PIPE)	9/88		9-440			
		ES-WALLS OF PIPE GALLERY BELOW 732', FLOOR OF PIPE GALLERY & WALLS OF VAULTS BETWEEN 725' & 732'	9/88					9- 50 16- 75 @ CONTACT
A.12.3.8.13	RWP YARD - AREA 13, COOLING TOWER FOUNDATIONS AND PUMP PIT	RE-COOLING TOWER FOUNDATION AND CONCRETE IN INTERCONNECTING TRENCH AND PUMP PITS ABOVE 732'	8/88		6- 14			
		ES-CONCRETE IN INTERCONNECTING TRENCH AND PUMP PITS BELOW 732'	8/88					6- 9 @ CONTACT
A.12.3.8.14	RWP YARD - AREA 14, TRENCH COVERS & SHIELD PLUGS	RE-ALL	7/88		11- 63			
A.12.3.8.15	RWP YARD - AREA 15, UPPER TRENCHES	RE-CONCRETE WALLS & FLOORS ABOVE 732'	5/88		9-170			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 μR/h @ CONTACT	RESIDENTIAL 900 μR/h @ CONTACT	OCCUPANCY 200 μR/h @ CONTACT	OCCUPANCY 50 μR/h @ 1 m	EXPOSED SLAB 600 μR/h @ 0.5 m
A.12.3.8.15 CONTINUED	RWP YARD - AREA 15, UPPER TRENCHES	ES-CONCRETE WALLS AND FLOORS BELOW 732'	5/88					16- 36 9-300 @ CONTACT
A.12.3.8.16	RWP YARD - AREA 16, LOWER TRENCHES MANHOLES & VITRIFIED CLAY DRAINS[b]	SECTION 1						
		RE-CONDENSER PIT VAULT CEILING, FLOOR, AND WALLS BELOW 725', AND THE ENTIRETY OF TRENCHES A-1 THROUGH A-4	7/88		11-150			
		ES-THE WALLS OF CONDENSER PIT VAULT BETWEEN 725' AND 730'	7/88					11- 26 @ CONTACT
		SECTION 2						
		RE-VALVE PIT #1 AND #2 ABOVE 732' RE-TRENCHES B1, B2, B3, THE THREE PIPE SLEEVES BETWEEN TRENCH B1 AND THE CONDENSER PIT VAULT, VALVE PIT #1 BELOW 724'-8" AND VALVE PIT #2 BELOW 725'-4"	7/88	11- 26	14-300			
		ES-VALVE PIT #1 BETWEEN 724'-8" AND 732'	7/88					21-120 @ CONTACT
		OC-VALVE PIT #2 BETWEEN 725'-4" AND 732'	7/88			16- 38		

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900µ R/h @ CONTACT	OCCUPANCY 200µ R/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600µ R/h @ 0.5 m
A.12.3.8.16 CONTINUED	RWP YARD - AREA 16, LOWER TRENCHES MANHOLES & VITRIFIED CLAY DRAINS[b]	SECTION 3						
		RE-CONCRETE ROOF AND WALL OF VALVE PIT #3 ABOVE 732'	8/88		9- 41			
		ES-CONCRETE WALLS AND FLOOR OF VALVE PIT #3 BELOW 732' AND ALL OF AREA C & D	8/88					43 16-250 @ CONTACT
		SECTION 4						
		RE-CONCRETE ROOF AND WALLS OF VALVE PITS 4 AND 5 RE-CONCRETE FLOOR AND WALLS BELOW 725' IN TRENCHES E-1, E-2, F-1, AND F-2	8/88	11-21	9-220			
		ES-CONCRETE WALLS ABOVE 725' IN TRENCHES E-1, E-2, F-1, AND F-2						9-200 @ CONTACT
		OC-CONCRETE WALLS AND FLOOR OF VALVE PITS 4 & 5	8/88			11-300	26	
		SECTION 5						
		RE-CONCRETE WALLS AND FLOOR OF AREA G BELOW 725', WALLS OF AREA H AND REMAINING TRENCH COVER ON THE PIT IN AREA 6	8/88		11-200			
		ES-CONCRETE ROOF AND WALLS OF AREA G ABOVE 725' (EXCLUDING THE TRENCH COVER ON THE PIT OF AREA G) AND WALLS AND FLOOR OF AREA H BELOW 732'	8/88					11-420 @ CONTACT

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
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SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 μR/h @ CONTACT	900 μR/h @ CONTACT	200 μR/h @ CONTACT	50 μR/h @ 1 m	600 μR/h @ 0.5 m
A.12.3.8.16 CONTINUED	RWP - AREA 16, LOWER TRENCHES MANHOLES & VITRIFIED CLAY DRAINS[b]	SECTION 6						
		RE-CONCRETE TRENCH COVERS ON THE NORTH END OF TRENCHES K-2 AND K-3	8/88	11- 16				
		ES-CONCRETE WALLS AND FLOORS OF THE NORTH END OF TRENCHES K-2 & K-3	8/88					11- 31 @ CONTACT
		SECTION 7						
		RE-VITRIFIED CLAY DRAINS	8/88		3- 21			
		SECTION 8						
		RE-CONCRETE CEILINGS OF TRENCHES IN AREA J, K, THE PIT IN AREA J, AND VALVE PIT #6, THE EXPOSED ROOFS IN THESE AREAS; WALLS ABOVE 732', THE WALL AND FOUNDATION OF THE RWP BUILDING ABOVE 732', AND THE SUMP OF VALVE PIT #6 BELOW 725'	9/88		9- 440			
		ES-CONCRETE WALLS AND FLOORS OF TRENCHES IN AREAS K & J AND VALVE PIT #6 BETWEEN 725' & 732'; AND THE FOUNDATION OF THE RWP BUILDING BELOW 732'	9/88					10-110 14-370 @ CONTACT

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
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SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.9.2	FUEL HANDLING BUILDING AREA 15 DECONTAMINATION ROOM	RE-ALL	9/87, 1/88		9-150			
A.12.3.9.3	FUEL HANDLING BUILDING AREA 16 1B MECHANICAL EQUIPMENT ROOM	RE-ALL	11/87		9- 14			
A.12.3.9.4	FUEL HANDLING BUILDING - AREA 17 CLEAN ROOM	RE-RUBBLE ABOVE 725'	1/88	4- 14				
		RE-CONCRETE WALLS2AND CEILING ABOVE 732'	1/88		4- 14			
		OC-CONCRETE WALLS & FLOOR BELOW 732'	1/88			4- 14		
		ES-CONCRETE FLOOR OF DEGREASING PIT	1/88					7- 11 @ CONTACT
A.12.3.9.5	FUEL HANDLING BUILDING - AREA 2 HEAD STORAGE PIT	RE-CONCRETE WALLS ABOVE 732'	12/87		14- 21			
		OC-PIT WALLS AND FLOOR BELOW 732'	12/87			14- 95	48	
A.12.3.9.6	FUEL HANDLING BUILDING - AREA 9 DEEP PIT	RE-CONCRETE WALLS ABOVE 732' AND THE UNOCCUPIABLE PORTION OF THE GATE GUIDE SLOT BELOW 732'	4/88		16-1100			
		OC-CONCRETE WALLS AND FLOOR BELOW 732'	4/88			11-350	30-36	

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 μR/h @ CONTACT	RESIDENTIAL 900 μR/h @ CONTACT	OCCUPANCY 200 μR/h @ CONTACT	OCCUPANCY 50 μR/h @ 1 m	EXPOSED SLAB 600 μR/h @ 0.5 m
A.12.3.9.7	FUEL HANDLING BUILDING AREA 1 FUEL STORAGE PIT[b]	RE-CONCRETE WALLS ABOVE 732'	12/87, 1/88,		9- 440			
		OC-CONCRETE WALLS & FLOOR BELOW 732'	4/88			16-1000	16-48	
A.12.3.9.8	FUEL HANDLING BUILDING AREA 12 REACTOR PIT	RE-CONCRETE WALLS ABOVE 732'	4/88, 6/88			16- 85		
		OC-CONCRETE WALLS BELOW 732'	4/88, 6/88, 6/89			16- 200	16-63	
A.12.3.9.9	FUEL HANDLING BUILDING AREA 3 CASK STORAGE PITS	RE-CONCRETE WALLS AND CEILING ABOVE 732'	10/87		21- 50			
		ES-CONCRETE WALLS AND FLOOR BELOW 732'	10/87					12- 41 @ CONTACT
A.12.3.9.10	FUEL HANDLING BUILDING - AREA 5 CANAL PUMP PITS[b]	RE-CONCRETE WALLS AND CEILING ABOVE 732' AND BELOW 725'	3/88, 4/88		23-5700			
		OC-CONCRETE WALLS BETWEEN 725' AND 732'	3/88					23- 35

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL		OCCUPANCY		EXPOSED SLAB
				15 µR/h @ CONTACT	900 µR/h @ CONTACT	200 µR/h @ CONTACT	50 µR/h @ 1 m	600 µR/h @ 0.5 m
A.12.3.9.11	FUEL HANDLING BUILDING AREA 6 CRANE LOCK PIT	RE-CONCRETE WALLS ABOVE 732' AND BELOW 725' AND THE FLOOR INCLUDING THE STEEL ASSOCIATED WITH THE GATE GUIDES	3/88		20-1100			
		ES-CONCRETE WALLS BETWEEN 732' & 725' INCLUDING THE STEEL ASSOCIATED WITH THE GATE GUIDES	3/88					50-700 @ CONTACT
A.12.3.9.12	FUEL HANDLING BUILDING AREA 7 DRY PIT	RE-CONCRETE WALLS ABOVE 732' AND BELOW 725' AND THE FLOOR	3/88		23- 470			
		ES-CONCRETE WALLS BETWEEN 732' AND 725'	3/88					23- 47 @ CONTACT
A.12.3.9.13	FUEL HANDLING BUILDING AREA 18 SOUTH WALL	RE-SOUTH CONCRETE WALL	1/88		7- 10			
A.12.3.9.14	FUEL HANDLING BUILDING AREA 19 ROOF CONCRETE	RE-CONCRETE ROOF	1/88, 2/88		14- 50			
A.12.3.9.16	FUEL HANDLING BUILDING AREA 8 SHROUD STORAGE PIT	RE-CONCRETE WALLS ABOVE 732' & BELOW 725' & THE FLOOR	2/88		16- 150			
		ES-CONCRETE WALLS BETWEEN 732' & 725'	2/88					16- 36 @ CONTACT
A.12.3.9.17	FUEL HANDLING BUILDING AREA 10 A/C AND B/D STAIRWELLS	RE-CONCRETE ABOVE 732' AND THE B/D STAIRWELL UPPER AND LOWER TUNNELS	4/88			9- 16		

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.9.17 CONTINUED		OC-CONCRETE FLOORS AND WALLS BELOW 732' (EXCLUDING THE B/D TUNNELS)	4/88			9- 16	11	
A.12.3.9.18	FUEL HANDLING BUILDING AREA 11 TRANSITION PIT	RE-CONCRETE WALLS ABOVE 732' OC-CONCRETE FLOOR AND WALLS BELOW 732'	3/88 3/88		21- 300	50-250	21-41	
A.12.3.9.19	FUEL HANDLING BUILDING AREA 13 FLOOR AND HORIZONTAL CANAL AREAS	RE-CONCRETE FLOOR AND HORIZONTAL CANAL AREAS	4/88		11- 95			
A.12.3.9.20	FUEL HANDLING BUILDING AREA 14 WALLS AND MEZZANINES	RE-CONCRETE WALLS AND MEZZANINES	2/88, 3/88		9- 26			
A.12.3.10.1	CONTAMINATED EQUIPMENT ROOM	RE-CONCRETE FLOOR AND TRENCH WALLS ABOVE 732' COMPACTOR WALL CONCRETE TRENCH PORTIONS BELOW 732'	9/87, 12/87		11- 88			
A.12.3.12.1	A/C ENCLOSURE	RE-A/C ENCLOSURE ROOF, NORTH WALL FROM THE NORTHWEST CORNER EAST TO THE VERTICAL WHERE THE NORTH WALL MEETS THE EAST WALL OF THE AUXILIARY ENCLOSURE, THE EAST WALL FROM THE SOUTHEAST CORNER NORTH TO A VERTICAL LINE 8' SOUTH OF THE JOINT OF THE OUTSIDE WALL OF THE VESTIBULE OF THE ADMINISTRATION BUILDING AND THE ENCLOSURE WALL, THE SOUTH AND WEST WALLS AND THE EMERGENCY STAIRWELL ALL ABOVE 732'. THE ACCESS TUNNEL, WALL PENETRATION AND EMERGENCY STAIRWELL BELOW	4/88, 5/88		3- 75			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.12.1 CONTINUED	A/C ENCLOSURE	ALSO THE STEEL EMBEDDED IN THE BIO-SHIELD WALL, THE TWO ROLLER BEARING SUPPORTS AND THE FIXED BEARING SUPPORT.						
		ES-THE EMERGENCY STAIRWELL BETWEEN 732' & 725'	5/88					9- 12 @ CONTACT
		OC-THE FLOOR, REMAINING PORTIONS OF THE NORTH AND EAST WALLS BELOW 735', AND THE SOUTH AND WEST WALLS BELOW 732'	5/88		5- 90	21- 31		
A.12.3.12.2	A/C CHAMBER CONCRETE SHIELD WALL BETWEEN "A" LOOP AND "C" LOOP, WEST FACE OF SHIELD WALL, WEST END OF "A" & "C" LOOPS, INTERCONNECTS PURIFICATION AREA, AND THE GRAVITY DRAIN LINE[b]	RE-CONCRETE WALLS ABOVE 732', THE CONCRETE IN THE PURIFICATION AREA BELOW 725' AND PENETRATIONS BELOW 732'	5/88		6- 300			
		ES-IN THE PURIFICATION AREA: THE AREA INSIDE THE THE SHIELD WALLS AND INTERCONNECTS BETWEEN 725'	5/88					7-100 @ CONTACT
		OC-A/C PURIFICATION CONCRETE BETWEEN 730'-6" & 732', AND THE SHIELD WALLS AND INTERCONNECTS BELOW 732'	5/88			6- 130	10- 21	
A.12.3.13.1	B/D ENCLOSURE	RE-B/D ENCLOSURE CONCRETE ROOF AND WALLS ABOVE 732'	11/87, 5/88		9- 490			
		OC-CONCRETE FLOOR AND WALLS BELOW 732'	11/87, 5/88		3- 370	19		

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 μR/h @ CONTACT	RESIDENTIAL 900 μR/h @ CONTACT	OCCUPANCY 200 μR/h @ CONTACT	OCCUPANCY 50 μR/h @ 1 m	EXPOSED SLAB 600 μR/h @ 0.5 m
A.12.3.13.2	B/D CHAMBER[b]	RE-INSIDE THE DEMINERALIZER CUBICLE FROM 725' TO 710' AND UNDER THE PURIFICATION CUBICLE FROM 710' TO 703'	11/87, 5/88		19- 430			
		ES-INSIDE THE DEMINERALIZER CUBICLE BETWEEN THE TOP (730') TO 725'	11/87, 5/88					26- 31 50 @ CONTACT
		OC-THE DEMINERALIZER CUBICLE OUTSIDE NORTH, NORTHWEST, WEST WALL AND TOP, THE B/D PURIFICATION AREA NORTH WALL, EAST WALL AND NORTH FLOOR, AND THE SHIELD WALL JOINTS	4/88, 3/88, 11/87			4- 890	9- 31	
A.12.2.14.1	AUXILIARY ENCLOSURE	RE-STAIRWELL WALLS ABOVE 732' AND BELOW 725', PASSAGEWAY WALLS FROM STAIRWELL TO THE FUEL HANDLING BUILDING, A/C AND B/D INTERCONNECTS, RUBBLED PORTIONS OF THE ENCLOSURE CEILING AND WEST AND SOUTH WALLS, GRAVITY DRAIN PIT SUMP, SCABBLED GRAVITY DRAIN PIT FLOOR, ENTRANCE FROM THE B-3 LEVEL OF THE TURBINE BUILDING, THE SHOWER FLOOR AND PENETRATIONS IN THE WALLS THAT REMAIN	6/87, 10/87, 12/87, 2/88, 4/88, 6/88, 5/89		4-4000			
		ES-STAIRWELL WALLS BETWEEN 732' AND 725'	10/87					11- 14 @ CONTACT
		OC-ENCLOSURE WALLS THAT REMAIN INTACT, FINAL GRAVITY DRAIN PIT FLOOR, ENCLOSURE FLOOR	2/88, 5/88, 6/88			6- 900	9- 41	

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.14.2	AUXILIARY CHAMBER	RE-ALL	5/88, 6/88		3- 400			
A.12.3.14.2	AUXILIARY CHAMBER	RE-ALL	5/88, 6/88		3- 400			
A.12.3.15.1	REACTOR ENCLOSURE AND CHAMBER	OC-ALL	6/88, 1/89			26- 65	26- 70	
A.12.3.17.1	LAYDOWN BUILDING	RE-ALL	11/88	6- 16				
A.12.3.18.1	DEMINERALIZER BUILDING	RE-A THREE FOOT SECTION OF TRENCH THAT IS 3' BELOW FINAL GRADE (735')	6/88	2- 17				
		RE-ALL CONCRETE & CONCRETE BLOCK WITH 2 EXCEPTIONS	6/88		9- 940			
		ES-THE CONCRETE PAD NORTH OF THE DEMINERALIZER BUILDING	6/88					100-150
A.12.3.19.1	CORE VAULT	RE-ALL	8/87, 11/87		9- 120			
A.12.3.20.1	ADMINISTRATION BUILDING AUXILIARY POWER ROOM	RE-CONCRETE CEILING, FLOOR, AND SOUTH, NORTH, AND WEST WALLS	9/87, 12/87		8- 26			
A.12.3.21.1	AUXILIARY CONTROL ROOM	RE-CONCRETE WALLS AND FLOOR	8/87	9- 14				
A.12.3.22.1	ENCLOSURE HATCH SHIELD PLUGS	RE-ALL	8/88		6- 14			
A.12.3.22.2	DEMINERALIZER SHIELD PLUGS	RE-ALL	9/88		9-2200			

TABLE 4 (CONTINUED)

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE RESIDENTIAL,
OCCUPANCY, AND EXPOSED SLAB SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SCENARIO AND PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	RESIDENTIAL 15 µR/h @ CONTACT	RESIDENTIAL 900 µR/h @ CONTACT	OCCUPANCY 200 µR/h @ CONTACT	OCCUPANCY 50 µR/h @ 1 m	EXPOSED SLAB 600 µR/h @ 0.5 m
A.12.3.23.1	EFFLUENT HEADER[c]	RE-PORTION OF EFFLUENT HEADER WITHIN 3 METERS	4/88	6- 60				
		RE-PORTION OF THE EFFLUENT HEADER GREATER THAN 3 METERS BELOW THE SURFACE	4/88		200- 600			
A.12.3.23.1 CONTINUED	EFFLUENT HEADER	ES-PORTION OF EFFLUENT HEADER WITHIN 3 METERS OF THE SURFACE	4/88					6- 60 @ CONTACT
A.12.3.24.3	TANK FOUNDATIONS & TRENCHES AREA 3, TRENCHES: 7/8, 13, 9, 1/10 NE & N, 8S, 10, 11E, 11W, 14E, 14W, 12	ES-CONCRETE WALLS AND FLOORS	3/87, 4/87, 6/87, 8/87					16- 150 @ CONTACT
A.12.3.24.6	TANK FOUNDATIONS & TRENCHES AREA 6 TANK AND MISCELLANEOUS FOUNDATIONS[a]	RE-CONCRETE ABOVE 732'	6/88	11- 59				
		RE-EAST YARD RUBBLE	6/88					
		OC-CONCRETE BELOW 732'	6/88			11- 23		

[a]Refer to Table 7 for radionuclide concentrations in soil.
[b]Refer to Table 6 for survey data in support of areas released to the Embedded Pipe scenarios.
[c]The souvenir scenario was applied to the portion of the effluent header within 3 meters of the surface; it also met this criteria.

TABLE 5

SUMMARY OF EXPOSURE RATE MEASUREMENTS
FOR AREAS RELEASED TO THE EMBEDDED PIPE SCENARIOS
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	PORTION OF AREA WHERE APPLICABLE	SURVEY DATES	PIPE DIAMETER (inches)	CRITERIA µR/h	RANGE µR/h
A.12.3.8.12	RWP YARD AREA 12 ION EXCHANGER ENCLOSURE	VAULT TEST SUMP SLEEVES	9/88	3	18,000	450- 3000
				6	11,700	270- 820
A.12.3.8.16	RWP YARD AREA 16 LOWER TRENCHES, MANHOLES AND VITRIFIED CLAY DRAIN LINES	TRENCH SUMP TEST PIPES	8/88	4	1,100	3- 21
A.12.3.9.7	FUEL HANDLING BUILDING AREA 1, FUEL STORAGE PIT	FUEL STORAGE PIT DRAIN PIPE	4/88	12	5,300	220- 350
A.12.3.9.10	FUEL HANDLING BUILDING AREA 5, PUMP PITS	INTERCONNECT BETWEEN DEEP PUMP PIT AND FUEL STORAGE PUMP PIT			5,300	150- 500
A.12.3.9.15	FUEL HANDLING BUILDING AREA 4	DRAIN LINE FROM SHROUD PIT DRAIN LINES FROM REACTOR PIT, CRANE LOCK, DEEP PIT & FUEL STORAGE	2/88	4	18,000	770- 4200
				12	5,300	350- 3400
A.12.3.12.2	A/C CHAMBER	GRAVITY DRAIN LINE	4/88	6	11,700	120- 380
A.12.3.13.2	B/D CHAMBER	SLEEVED PENETRATION THROUGH THE BIO-SHIELD WALL BETWEEN B AND D BOILER CHAMBERS	1/88	NA	11,700	13- 50
A.12.3.14.3	AUXILIARY ENCLOSURE	FLOOR DRAIN LINE		6	11,700	20- 1500
		GRAVITY DRAIN LINE		12	5,300	100-17500

TABLE 6

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN SOIL
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SAMPLE DATES	Co-60[a] GUIDELINE (pCi/g)	# OF SAMPLES	RANGE OF RADIONUCLIDE CONCENTRATIONS pCi/g		
					Co-60	Cs-137	Sb-125
A.12.3.3.1	HEAT DISSIPATION SYSTEM	2/87	6	1	<0.1	0.3 ± 0.1[b]	<0.1
A.12.3.4.1	1A AUXILIARY EQUIPMENT ROOM	1/88	6	4	<0.1 - 0.9 ± 0.2	<0.1 - 0.1 ± 0.1	<0.1 - 0.3 ± 0.2
A.12.3.5.1	1B AUXILIARY EQUIPMENT ROOM BLOCK WALLS	9/87	6	7	<0.1	<0.1	<0.4
A.12.3.7.5	RWP BLDG. AREA D, SURGE AND DECAY TANK ROOMS SUSPECT SURFACES	9/88	6	1	<0.1	<0.1	<0.1
A.12.3.24.3	TANK FOUNDATIONS AND TRENCHES AREA 3, TRENCHES: 7/8, 13, 9, 1/10 NE, 8N, 8S, 10, 11E, 11W, 14E, 14W, 12	2/87, 3/87, 6/87, 8/87, 11/87	6	70	<0.1 - 1.5 ± 0.2	<0.1 - 0.6 ± 0.1	<0.2
A.12.3.24.6	TANK FOUNDATIONS AND TRENCHES - AREA 6 TANK AND MISC. FOUNDATIONS	6/88, 10/88, 6/87, 11/87, 12/87	100	4	<0.1 - 0.2 ± 0.1	0.1 ± 0.1 - 0.2 ± 0.1	<0.1
A.12.3.25.1	SITE SOIL						
	EAST YARD	1/88, 3/88, 6/88	6	25	<0.1 - 3.0 ± 0.3	<0.1 - 0.1 ± 0.2	<0.1 - 19 ± 0.9
			100	3	0.2 ± 0.1 - 120 ± 6.0	<0.1 - 0.2 ± 0.2	<0.1 - 0.2 ± 0.3
	REACTOR SERVICE BUILDING	4/88	100	3	0.2 ± 0.1 - 0.3 ± 0.1	<0.1 - 0.1 ± 0.1	<0.1
	RWP YARD	8/88	6	7	0.1 ± 0.1 - 46 ± 1.0	0.1 ± 0.1 - 3.5 ± 0.2	<0.4
			100	3	3.2 ± 9.1 - 14 ± 0.3	0.3 ± 0.1 - 0.5 ± 0.1	<0.2

TABLE 6 (CONTINUED)

SUMMARY OF RADIONUCLIDE CONCENTRATIONS IN SOIL
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	SAMPLE DATES	Co-60 GUIDELINE (pCi/g)	# OF SAMPLES	RANGE OF RADIONUCLIDE CONCENTRATIONS pCi/g Co-60	Cs-137	Sb-125
A.12.3.25.1 (Cont.)	RWP YARD	9/88, 11/88	6	5	1.8 ± 0.1 - 11 ± 0.1	<0.1 - 0.9 ± 0.1	<0.1 - 7.6 ± 0.3
	SOUTHEAST CORNER		100	4	7.1 ± 0.2 - 71 ± 0.7	<0.1 - 3.2 ± 0.2	<0.3
	COMPOSITES	4/89	6	38	<0.1 - 0.8 ± 0.1	<0.1 - 0.5 ± 0.1	< 0.1 - 0.2 ± 0.1
	BOREHOLES 0-3m[c]	4/89	6	38	<0.1 - 0.6 ± 0.2	<0.1 - 3.8 ± 0.3	0.1 ± 0.1 - 0.6 ± 0.1
	GE BOREHOLES 0-3m[d]	4/89	6	7	<0.5	<0.1 - 0.2 ± 0.1	<0.1
	BOREHOLES 3m-7m[c]	4/89	100	9	<0.1 - 1.3 ± 0.2	<0.1 - 1.8 ± 0.2	<0.4
	GE BOREHOLES 3m-7m[d]	4/89	100	10	<0.1 - 0.2 ± 0.2	<0.4	<0.1 - 1.1 ± 0.1

[a]Cobalt 60 was the controlling radionuclide; the guidelines for the other potential contaminants are 25 and 100 pCi/g and 50 and 250 pCi/g for Cs-137 and Sb-125 for the upper 3 meters and greater than 3 meters below the surface, respectively.

[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

[c]Samples collected by ORAU during the GE drilling phase.

[d]Samples collected by GE and analyzed by ORAU.

TABLE 7

SUMMARY OF SURFACE CONTAMINATION MEASUREMENTS
FOR AREAS AND MATERIALS RELEASED TO
REGULATORY GUIDE 1.86
SHIPPINGPORT ATOMIC POWER STATION
SHIPPINGPORT, PENNSYLVANIA

FILE #	TITLE	AREA OR MATERIAL	SURVEY DATES	# OF MEASUREMENTS	RANGE OF MEASUREMENTS: TOTAL BETA-GAMMA CONTAMINATION (dpm/100 cm^2)	RANGE OF MEASUREMENTS: REMOVABLE BETA CONTAMINATION (dpm/100 cm^2)
A.12.3.16.1	EXPOSED SURFACES	ABOVE GRADE CONCRETE WALL OF THE A/C ENCLOSURE, AUXILIARY ENCLOSURE, SIS PUMP HOUSE, SIS RETAINING WALL, SIS DEEP WELL, HDS RETAINING WALL, AUXILIARY POWER ROOM WALL, AND ROOF OF THE AUXILIARY CONTROL ROOM	8/89	25	<350- 520	<6- 9
A.12.3.25.1	SITE SOIL	MANHOLES, STORM DRAINS AND CONNECTING PIPING	5/89	27	<340-2400	<6-20
N/A	TRANSITION ZONES	GUARD SHACK	8/89	3	<350	<6
		TEST AND TRAINING BUILDING	8/89	5	<350	<6
		ADMINISTRATION BUILDING	8/89	14	<350- 550	<6- 9
		TURBINE BUILDING	8/89	20	<350- 640	<6-10
N/A	MATERIALS FOR SALVAGE	STEEL FROM AUXILIARY CHAMBER	11/88	11	<340	<7
			11/88	65	<430	<6-18
		STEEL FROM LAYDOWN BUILDING	1/89	10	<430	<6
	GUIDELINE				5,000	1,000

REFERENCES

1. General Electric Company, Site Release Record Shippingport Station Decommissioning Project, Shippingport, Pennsylvania, August 1989.

2. Eger, K.J., Final Consolidated Implementation Plan for the Shippingport Station Decommissioning Project Site Release Criteria, Revision 1, Shippingport, Pennsylvania, July 13, 1988.

3. General Electric Company, Post-Remedial Action Report for the Shippingport Atomic Power Station, Shippingport, Beaver County, Pennsylvania, Shippingport, Pennsylvania, October 1989.

4. Memorandum, A. Wallo (DOE/HQ) to W. Murphie (DOE/HQ), "Approval of Request for Application of Supplemental Limits to the Shippingport Atomic Power Reactor Enclosure Chamber", March 8, 1989.

5. U.S. Department of Energy, Guidelines for Residual Radioactivity at Formerly Utilized Sites, Remedial Action Program and Remote Surplus Facilities Management Program Sites, Revision 2, March 1987.

APPENDIX A

SUMMARY OF RADIATION GUIDELINES APPLICABLE TO THE SHIPPINGPORT ATOMIC POWER STATION

FINAL CONSOLIDATED IMPLEMENTATION PLAN
FOR THE SHIPPINGPORT STATION DECOMMISSIONING PROJECT
SITE RELEASE CRITERIA

Kenneth J. Eger

Revision 1

July 13, 1988

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FINAL CONSOLIDATED IMPLEMENTATION PLAN

FOR THE SHIPPINGPORT STATION DECOMMISSIONING PROJECT

SITE RELEASE CRITERIA

Kenneth J. Eger

Revision 1

July 13, 1988

The release criteria applicable to SSDP were issued by DOE-HQ on December 29, 1986 and formally transmitted to GE, the Decommissioning Operations Contractor (DOC) on January 6, 1987. It was defined as "...100 mrem/year total committed effective dose equivalent to the maximum exposed individual of the general public under the worst case scenario;..." In addition the DOC was directed to apply the philosophy of ALARA to the release of the site.

Table 1 values from Regulatory Guide 1.86 were established as goals for the project, although provision was made for DOE concurrence for release at higher concentrations (but not in excess of the limit), if achievement of the goals should be too costly, in terms of either dose or direct dollars.

The implementation of the site release criteria is developed in this document by the specification of limiting conditions, which cannot be exceeded if the site is to be released unconditionally, and the description of the field application of these limiting conditions. The definition of the applicable scenarios which serve as the basis for the limiting conditions follows, along with a discussion of the ALARA philosophy and the approach to reaching Regulatory Guide 1.86 goals.

Appendices A, B and C were prepared at the request of the DOE for support in the issuance of the site specific criteria. Appendix A shows what the annual dose would be to a future resident of the site. It also estimates the costs that would be incurred and the dose reductions that would be realized if various remedial actions were to be undertaken. Appendix B is a cost-benefit analysis which defines the exposure costs for construction of a slab-on-grade building over the unscabbled Fuel Handling Building canal. This is subsequently compared with the dollar and exposure costs for scabbling. Appendix C contains a worst case assessment of the dose to an individual from the decommissioned site, if the walls of the Fuel Handling Building canal were not scabbled. This analysis has led directly to the application of the 100 mrem/year DOE criteria to this the "worst case scenario", and to the conclusion that the walls of the Fuel Handling Building canal have to be scabbled.

LIMITING CONDITIONS FOR RELEASE

The limiting conditions which could exist on the site without causing the release criteria to be exceeded were generated, based on the scenario envelope discussed in a later section. The conditions are specified by reference to cobalt-60 since it is the most abundant residual radionuclide, and delivers the greatest dose per curie.

These are shown in Figure 1, and listed as follows:

- Top 3 meters of soil: The average concentration must be less than 6 pCi/gram ^{60}Co. Vertical averaging is limited to the top 0.15 meters and each 1 m thereafter, and horizontal averaging to 100 m^2.

- Other soil: The average concentration must be less than 100 pCi/gram ^{60}Co. Horizontal averaging is limited to 100 m^2. Vertical averaging is limited to 3 m. This limit effectively limits the concentration of any isotope in the groundwater since the latter occurs because of the leaching of the trace contaminants in the soil.

- Backfilled or buried potentially occupiable concrete substructure: The average exposure rate 1 meter from any wall in the "room" must be less than .05 mR/hour. Here hot spots would be limited to exposure rates of 1 mR/hour on contact, and the average contact exposure rate to 0.2 mR/hour. See Reference 1, Section C.4, †4. Beta exposure is not credible via the Occupancy Scenario as described in Appendix C.

- Souvenir: The average exposure rate from a souvenir must not exceed 2 mR/hour at contact. A 0.25 m cube of concrete reading less than 0.2 mR/hour at contact will read less than 0.015 mR/hour at 2 m. A dose equivalent of slightly less than 100 mrem/year would be received via this scenario.

- Exposed slab: The average exposure rate at 0.5 m must not exceed 0.6 mR/hour.

Three definitions supplement these limiting conditions by placing a restriction on the magnitude and extent of hot spots allowed, by specifying the appropriate modifications required when one is confronted with mixtures of radionuclides, and by addressing the release of embedded pipe. These are given as follows:

- Hot Spot Criteria: Above background concentrations of radionuclides in any region having an area (A) from 1 to 25 m^2 may exceed the applicable limit, but not by more than a factor of $(100/A)^{\frac{1}{2}}$. However, these hot spots are not to cause the average over 100 m^2 to exceed the limiting condition.

- Mixtures of radionuclides: Where mixtures of radionuclides exist, a region or area within a region can be released when the following sum is less than 1.0:

$$\sum_{i=1}^{3} \frac{\text{Concentration of Radionuclide "i" in Region}}{\text{Release Limit of Radionuclide "i" for Region (Table 1)}}$$

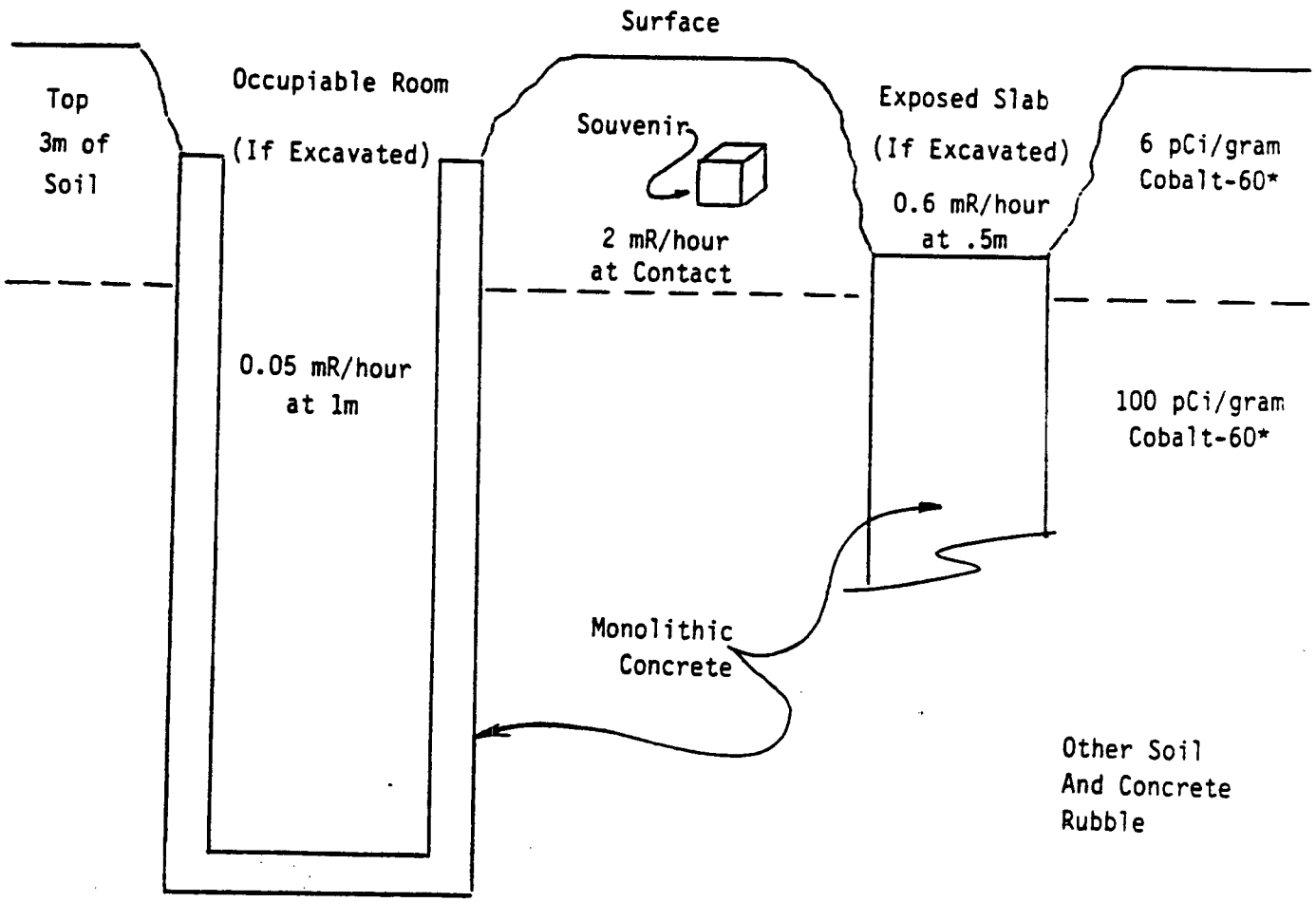
This assures that the dose to a future resident will not exceed the limiting conditions even if more than one radionuclide is present.

- Embedded Pipe: Contamination in embedded pipe is to be included with that in the adjacent concrete and the total shown to meet the limits specified for that depth of soil. The maximum volume for averaging shall be 1 m^3 for each 1 meter length of pipe. Attachment 6 of Appendix D contains limiting exposure rates for the center of pipes which correspond to the allowable average activity of 100 pCi/gram.

TABLE 1

Limiting Conditions for Single Individual Isotopes

Isotope	Average Concentration (pCi/g) ^{60}Co	^{125}Sb	^{137}Cs
Subsurface Region			
Top 3 meter	6	50	25
Other	100	250	100



*See Table 1 for other radionuclides

Figure 1

Pictorial Representation of the
Limiting Conditions for the
Shippingport Station Decommissioning Project

FIELD APPLICATION

The application of this implementation plan in the field will initially be done by regions. Individual rooms or trenches (or sets of trenches) will be surveyed, decontaminated, and released as they are decommissioned. Finally the conditions in the site soil will be assessed. This assessment will be based on information developed during decommissioning and concluded with a confirmatory soil sampling program.

The first step in the release process is the identification of a distinct area of interest. After that a review determination is to be made listing the applicable scenario and limits for each significant subpart of that area. For example portions of a backfilled or buried room might be occupiable, and others non-occupiable or to be rubbled. Additional parts near the surface may have to meet the exposed slab scenario.

The field limits which apply (and correspond to the applicable limiting conditions) are listed as follows:

Backfilled or buried potentially occupiable room	0.05 mR/hour at 1 m from wall and 0.2 mR/hour average at contact (1.0 mR/hour maximum at contact)
Exposed Slab	0.6 mR/hour at 0.5 m from slab
Rubbled, or adjacent to non-occupiable areas	0.9 mR/hour at contact

The next step in the release process is to survey the area of interest against these field limits to determine conformance or non-conformance. The survey pattern will be prescribed by Radiological Engineering. It will be based on the available knowledge of the history of the region so that more time and effort is spent in areas where contamination is expected.

Typical survey patterns or durations are given as shown in Table 2. Samples from concrete surfaces will also be taken to provide additional information about the site conditions. When the survey shows complete conformance with the limits, the area can be certified as released for unrestricted use. At this time access to the region is restricted to persons required for any final surveys.

A document package is prepared, including copies of the surveys, and other information pertinent to the conditions in the area. The region is then ready for a quality assurance check by the independent verification contractor (IVC).

The release of the area by DOE would follow IVC concurrence with the statement of readiness, and the DOE acceptance of the IVC formal report.

If a condition of non-conformance is identified, alternate paths are available.

In one case decontamination may be performed in the non-conforming areas, and the survey repeated. In the second case an engineering assessment can be made to determine if the non-conforming areas fall within the boundaries of established hot-spot criteria. See the "Limiting Conditions for Release" section of this document. When this can be shown the assessment is made part of the data package, and subjected to IVC review. When the hot-spot criteria are exceeded decontamination must be repeated until the necessary limits are met. Figure 2 shows the flow diagram for the release of distinct areas on-site, as described in the preceding text.

Following the release of distinct areas within the site, the final soil survey will be performed to demonstrate that site soil conforms to the limiting conditions and ALARA.

TABLE 2

Typical Survey Frequencies

For Concrete Substructures

History of Area	Typical Survey Duration
CONTAMINATED Expected to have been contaminated	10 min./10 m^2
SUSPECT Suspected to have been contaminated	30 min./50 m^2
CLEAN Expected to be clean	30 min./100 m^2
CONDITIONALLY CLEAN No known involvement or mechanism for contamination	30 min./1000 m^2

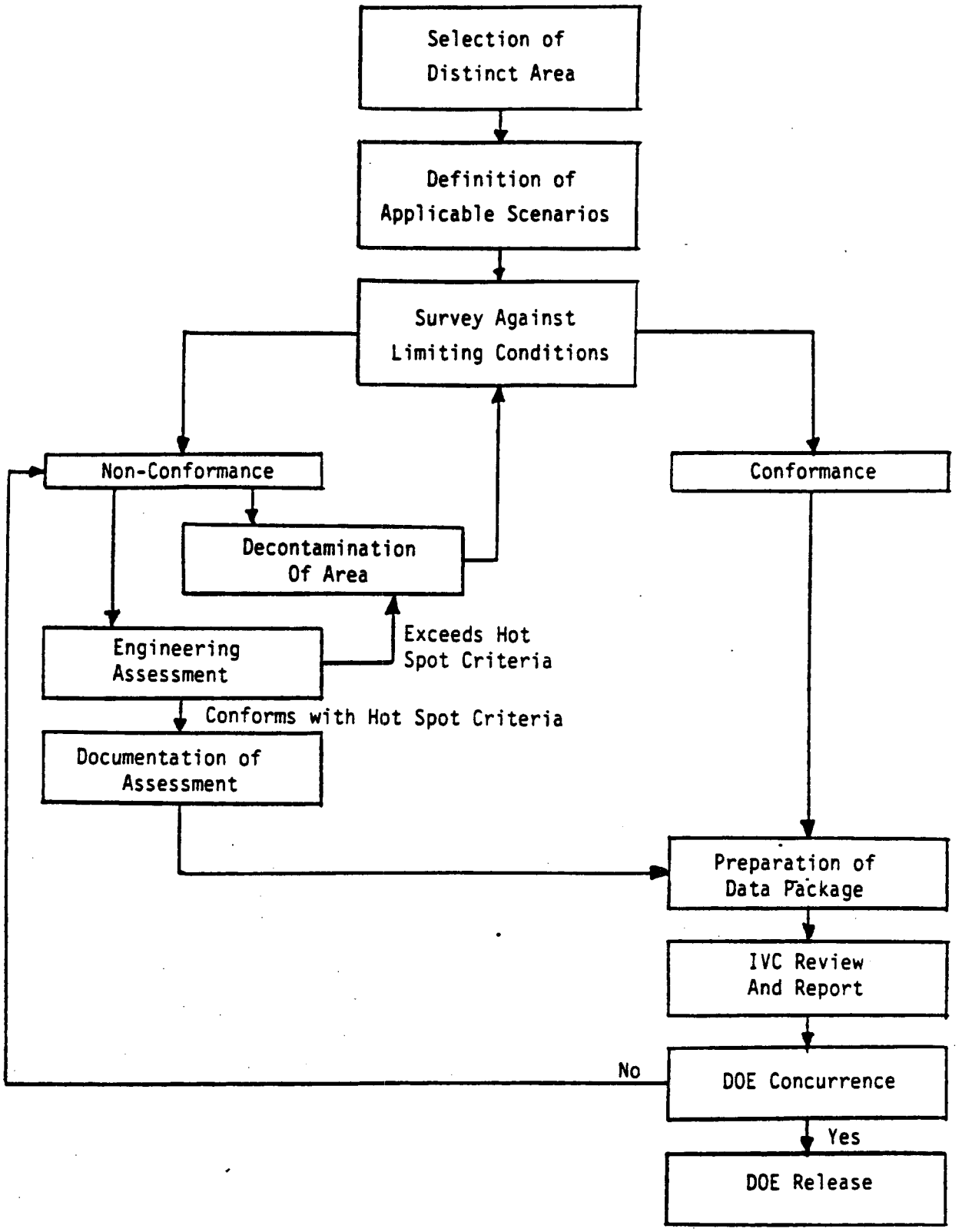


FIGURE 2

Flow Diagram for the Release of On-Site Areas

SCENARIO ENVELOPE

Four scenarios are considered which surround the credible uses of the site and set the practical limit for exposure of any member of the public to residual radioactivity.

The original scenario to be applied at SSDP is the scenario developed by Gilbert et.al. in the Working Draft "A Manual for Implementing Residual Radioactivity Guidelines"[2]. This scenario has the future resident living on the site and raising much of his own food-stuff. Water from an on-site well is used for household purposes. The farm family living on the site was established as the "critical population group" by Gilbert, and Kennedy[3] has shown that the dose to this group is orders of magnitude higher than those to any individuals living out of the immediate vicinity.

Three other scenarios were defined to surround the set of scenarios considered credible for the Shippingport site. The first of these is the "Occupancy Scenario". Here a person is assumed to excavate parts of the site and use the remaining concrete substructure to establish an office.

The two other scenarios are (1) the "Souvenir" scenario, where a person digs up a curious rock and takes it home with him/her, and (2) the "Exposed Slab" scenario. In this case a portion of the concrete substructure is exposed by excavation and occupied intermittently by curiosity seekers before it is covered over again.

These four scenarios address all the features of the decommissioned site. The "Occupancy" scenario considers the monolithic concrete substructure which has a configuration suitable for office space after excavation and refurbishment. The "Exposed Slab" scenario considers other monolithic concrete near the surface. The "Souvenir" scenario deals with broken pieces of concrete near the surface and the "Residential" scenario covers the site as a whole, considering the soil, monolithic concrete, and broken and powdered concrete not addressed in the other scenarios.

All other scenarios are considered to be either less likely than these or less restrictive, i.e., that individuals in the future are (1) less likely to be exposed, or (2) if exposed, they would be expected to get a lower dose.

The applicability of these four scenarios is defined in the following paragraphs.

RESIDENTIAL

It is postulated that a person builds a home on the site (including excavation of a basement down to elevation "-3 m"). The family that resides there has a garden, and livestock, and uses water from an on-site well. Particulars about this scenario are defined in detail in Reference (2). This is the scenario which considers the dose via the groundwater pathway. Dose calculations done for the residential scenario consider the migration of radionuclides from the soil into the family drinking water.

OCCUPANCY

It is postulated that a buried or backfilled concrete substructure which is open at the top somewhere within the top 3 meters of the site surface has been excavated and turned into an office area. The use is figured based on an occupancy of 40 hours/week and 50 weeks per year. The minimum size considered to be potentially occupiable is a room having a floor area of at least 10 m^2 and a minimum dimension of 3 m.

SOUVENIR

It is postulated that a piece of concrete weighing less than 50 kg, and located within three meters of the surface could be excavated and claimed for a souvenir. The exposed person would live 2 m from the souvenir, 18 hours per day all year around.

EXPOSED SLAB

Here it is postulated that monolithic concrete not amenable to occupancy, but existing within 3 m of the surface is exposed by excavation. The minimum area considered would be 2 m^2, and minimum dimension 1 m. It is to be occupied for up to 168 hours while it is exposed.

Note that all subsurface concrete not covered by the latter three scenarios is considered to be soil residing in the two layers defined for the residential scenario.

DEVELOPMENT OF THE LIMITING CONDITIONS FOR THE RESIDENTIAL SCENARIO

Limiting conditions for soil were established by doing parametric analyses using a computer program which had been developed to determine the dose to a future resident using the Draft DOE Manual (Reference 2). Table 3 gives the results from illustrative computer runs. Since the dose from any defined subsurface region is proportional to the average concentration in that region it is possible to select the maximum concentrations which could exist and still have the computed annual dose be less than 100 mrem per year.

Initially four subsurface regions were considered for these Residential scenario calculations, three layers of soil, and concrete (both monolithic and rubbled). These were reduced to the two shown in Figure 1 for simplicity. As shown in Table 3 the predominant pathway for exposure of the future resident is by direct exposure. Therefore the concentration in the surface layers of soil is most limiting. While there is a significant reduction in dose from a layer even 6" (.15m) below the surface, no near surface gradation was included in the limiting conditions.

A distinction was made, however, between the top 3 m and soil and concrete below 3 m. This 3 m is the excavation depth which the resident is assumed to choose when constructing a basement for his/her home. According to this model soil and rubble above this depth could be redistributed on or near the surface.

Below 3 m the radionuclides can cause very little exposure to the future resident and the limiting conditions chosen reflect this.

The actual limiting conditions were developed by an iterative process. First concentrations in the two layers of soil were estimated. Secondly, the annual dose was computed using Table 3 values. Finally, the process was repeated until an annual dose was found between 50 and 100 mrem/year.

This process is illustrated for the case where 3 pCi/g cobalt-60 occurs in the top 3 m of soil and 50 pCi/gram (also cobalt-60) occurs in lower soils. The formula used is given as follows:

$$\text{Total Annual Dose} = \sum_{\text{All Layers}} \frac{(\text{Actual Concentration})}{(\text{Table 3 Concentration})} (\text{Annual dose from Table 3})$$

Numerically this gives

$$(3/.6)(5.945) + (3/.8)(1.861) + (50/100)(.6719) + (50/100)(.1393)$$

or 37.1 mrem/year.

TABLE 3

Residential Scenario Dose Breakdown By Pathway
For Individual Isotopes in Specified Soil Regions

Top 0.15 m of Soil
Annual Dose (mrem/year)

Pathway	^{60}Co [.6]*	^{125}Sb [5]*	^{137}Cs [2]*
External	5.943E+00	6.758E+00	5.178E+00
Inhalation	9.678E-05	3.986E-05	5.237E-05
Ingestion	1.650E-03	6.243E-03	1.066E-02
Plant	1.517E-03	5.195E-03	2.647E-03
root uptake	1.491E-03	5.130E-03	2.192E-03
deposition	1.880E-05	5.498E-05	1.305E-04
water path	7.073E-06	9.422E-06	3.250E-04
Meat	7.995E-05	8.073E-04	6.612E-03
root uptake	7.343E-05	7.579E-04	3.238E-03
deposition	4.825E-06	4.241E-05	1.003E-03
water path	1.696E-06	7.044E-06	2.371E-03
Milk	4.589E-05	2.333E-04	1.082E-03
root uptake	4.337E-05	2.238E-04	6.374E-04
deposition	1.841E-06	8.092E-06	1.276E-04
water path	6.815E-07	1.409E-06	3.169E-04
Aquatic food	0.000E+00	0.000E+00	0.000E+00
Drinking	6.763E-06	9.482E-06	3.154E-04
Total	5.945E+00	6.765E+00	5.189E+00

Soil From 0.15 to 3.0 m Deep
Annual Dose (mrem/year)

Pathway	^{60}Co [.8]*	^{125}Sb [6]*	^{137}Cs [3]*
External	1.847E+00	1.339E+00	1.283E+00
Inhalation	0.000E+00	0.000E+00	0.000E+00
Ingestion	1.349E-02	4.613E-02	6.395E-02
Plant	1.250E-02	3.866E-02	2.129E-02
root uptake	1.246E-02	3.858E-02	2.060E-02
deposition	2.507E-05	6.598E-05	1.958E-04
water path	9.865E-06	1.232E-05	4.906E-04
Meat	6.224E-04	5.760E-03	3.582E-02
root uptake	6.136E-04	5.700E-03	3.044E-02
deposition	6.433E-06	5.089E-05	1.504E-03
water path	2.366E-06	9.212E-06	3.580E-03
Milk	3.658E-04	1.695E-03	6.661E-03
root uptake	3.624E-04	1.683E-03	5.992E-03
deposition	2.455E-06	9.710E-06	1.914E-04
water path	9.505E-07	1.843E-06	4.784E-04
Aquatic food	0.000E+00	0.000E+00	0.000E+00
Drinking	9.432E-06	1.240E-05	4.761E-04
Total	1.861E+00	1.386E+00	1.347E+00

*[ ] Average Concentration in Region (pCi/g)

TABLE 3 (Continued)

Residential Scenario Dose Breakdown By Pathway
For Individual Isotopes in Specified Soil Regions

Monolithic Concrete From 1.0 to 3.0 m Deep
Annual Dose (mrem/year)

Pathway	^{60}Co [100]*	^{125}Sb [250]*	^{137}Cs [100]*
External	1.536E-02	8.683E-04	6.653E-04
Inhalation	0.000E+00	0.000E+00	0.000E+00
Ingestion	6.536E-01	6.799E-01	3.360E-01
Plant	6.496E-01	6.699E-01	2.921E-01
root uptake	6.464E-01	6.671E-01	2.850E-01
deposition	3.134E-03	2.749E-03	6.526E-03
water path	5.680E-05	2.781E-05	5.702E-04
Meat	2.502E-03	7.718E-03	3.643E-02
root uptake	2.440E-03	7.554E-03	3.227E-02
deposition	6.163E-05	1.625E-04	3.844E-03
water path	1.228E-06	1.594E-06	3.189E-04
Milk	1.465E-03	2.262E-03	6.884E-03
root uptake	1.441E-03	2.231E-03	6.353E-03
deposition	2.352E-05	3.101E-05	4.889E-04
water path	4.933E-07	3.188E-07	4.262E-05
Aquatic food	0.000E+00	0.000E+00	1.460E-11
Drinking	6.387E-05	2.799E-05	5.534E-04
Total	6.719E-01	6.808E-01	3.366E-01

Concrete and Soil Below 3.0 m Deep
Annual Dose (mrem/year)

Pathway	^{60}Co [100]*	^{125}Sb [250]*	^{137}Cs [100]*
External	4.147E-12	4.223E-15	3.236E-15
Inhalation	0.000E+00	0.000E+00	0.000E+00
Ingestion	1.393E-01	1.575E-01	3.840E-01
Plant	1.267E-01	1.294E-01	7.713E-02
root uptake	1.220E-01	1.260E-01	5.381E-02
deposition	3.134E-03	2.749E-03	6.526E-03
water path	1.491E-03	7.373E-04	1.679E-02
Meat	7.171E-03	2.128E-02	2.522E-01
root uptake	6.009E-03	1.861E-02	7.949E-02
deposition	8.041E-04	2.120E-03	5.015E-02
water path	3.575E-04	5.513E-04	1.225E-01
Milk	3.999E-03	6.009E-03	3.840E-02
root uptake	3.549E-03	5.494E-03	1.563E-02
deposition	3.068E-04	4.046E-04	6.379E-03
water path	1.436E-04	1.103E-04	1.637E-02
Aquatic food	0.000E+00	0.000E+00	0.000E+00
Drinking	1.425E-03	7.421E-04	1.630E-02
Total	1.393E-01	1.575E-01	3.840E-01

*[ ] Average Concentration in Region (pCi/g)

APPLICATION OF ALARA

Reducing doses to values "As Low As Reasonably Achievable (ALARA)" at Shippingport is required as part of the release criteria. These doses can be determined by performing cost benefit analyses in which the costs of remediation are compared to the expected reduction in the exposure of people.

Such an analysis has been performed for the Shippingport Site using the Residential scenario as the basis for computing the dose to members of the general public. Since the Residential scenario is the worst case plausible scenario (or the most restrictive probable scenario) the doses saved have been compared directly with the remediation costs. This forces an assumption that the Residential scenario becomes a reality (Probability of Realization = 1).

This cost benefit analysis is included as Appendix A of this plan.

Note that while the annual doses in the cost-benefit analysis are based on September 15, 1986 data the release of the site is currently estimated to occur in early 1990. Therefore the doses were decay corrected to give April 1, 1990 values. Cobalt-60 was used as the reference radionuclide. Thus 5.56 mrem/year in the cost benefit analysis has become the 3.5 mrem/year cited in this discussion. Although cesium-137 decays more slowly than cobalt-60 it was not used as the reference. This is because it causes less exposure than a comparable amount of cobalt-60, and exists in generally lower net concentrations (some of it is due to fallout). Cesium-137 will become the controlling radionuclide after about 15 years, but it will never cause an annual dose in excess of 1 mrem.

Table 4 summarizes the application of ALARA in the residential scenario case. Here the dose equivalent to the future resident is reduced to 3.5 mrem per year by actions planned for decommissioning independently from efforts to remediate exposure. This is the reference point from which any dedicated efforts to reduce exposure should be measured.

One activity which has been proposed to further reduce the dose is to relocate 0.15m of the existing surface soil. This layer has been observed to have the highest soil concentrations, and to contribute the majority of the dose to the resident. Relocating it by using it for filling deep enclosures on site, and then replacing it with clean fill, would reduce the dose equivalent to the future resident from 3.5 to 2.1 mrem/year. This action is not part of the Decommissioning Plan and is a candidate for a true cost-benefit analysis. Costs estimated to be $30,000 would be required to achieve this reduction. If a family of eight were to use the site as described in the residential scenario the dose savings from this remedial action would be 85.3 man-mrem over their collective lifetimes. (Again, this was based on cobalt-60 decay.) Thus, the cost per man-rem avoided comes to $350,000. The corresponding expenditure per health effect avoided would be more than a billion dollars (based on one health effect

for 10,000 man-rem)[4]. Clearly such an expenditure cannot be justified on a rate basis. This action might be pursued as a matter of prudence, however, since the estimated direct costs are relatively low. In this and other minor cases sociological and political considerations might justify further remedial action where the ratio of dollar cost to exposure avoided would not.

The events comprising the other three scenarios (Occupancy, Exposed Slab, and Souvenir) are less likely to be realized when the site is considered independently from its neighbors. This is true for two reasons. First the chance that the required sequence of events will occur is remote, and secondly, the real occupancies would be much less than the postulated ones. Therefore, to do a cost-benefit analysis one would have to compare the remediation costs with the product of the calculated dose savings and the probability of realization.

As shown in Appendix D, the doses expected from the realization of each of these scenarios are on the order of a few mrem/year. Hence this is the maximum dose that could be saved.

For example, reducing the contact exposure rate from an slab from 0.6 mR/hour to 0.3 mR/hour could at best save 50 mrem/exposed person based on the Exposed Slab scenario and the limiting dose of 100 mrem/year. The expected savings however, would be much lower since the expected dose is conservatively estimated to be no more than 7.7 mrem/year. See Appendix D. The greatest expected savings would be 3.85 mrem/year. The maximum remediation cost which could be justified for avoiding this exposure would be $31 if 4 people were to be exposed and a unit cost of exposure of $2000/man-rem were used.

Since very little expenditure could be justified for reducing exposures (via these less probable scenarios) to anything less than the limiting conditions, reaching these conditions is in itself as low as reasonably achievable.

In reality, the entire Shippingport site is within the exclusion area of the adjacent Beaver Valley Nuclear Power Stations. Hence it is very unlikely that the Residential scenario will be realized before the cobalt-60 has decayed by one or two orders of magnitude. This reduced probability of realization make it still more difficult to justify any remedial action beyond the reference point defined in Table 4.

APPLICATION OF TABLE 1 OF REGULATORY GUIDE 1.86

Table 1 of Regulatory Guide "Acceptable Surface Contamination Levels" has been established as a goal for reducing residual contamination. This applies to any structure or equipment that is to remain usable.

However, these limits are not directly applicable to structures being demolished or buried.

TABLE 4

Application Of ALARA Using The Residential Scenario

Category	Annual Dose*	Cost/Health Effect Avoided	ALARA
Limit	100 mrem/year	N/A	N/A
Site (Per Plan)	3.5 mrem/year	0	Reference Point For Further Directed Remediation
Site With Remediation	2.1 mrem/year	$\$10^9$	**

*Based on the year 1990

**Approximately $30,000 would be required to reduce the dose to this value. This activity could not be justified strictly on the basis of the economic cost ratio indicated.

APPENDIX B

INSTRUMENTATION FOR VERIFICATION MEASUREMENTS

APPENDIX B

INSTRUMENTATION FOR VERIFICATION MEASUREMENTS

Type Measurement	Detector	Recording Instrument
SURFACE SCANS		
Gamma	Victoreen NaI Scintillator - Model 489-55	Eberline Ratemeter - Model PRM-6
Beta-Gamma	Eberline Pancake GM - Model HP-260	Eberline Scaler/Ratemeter - Model PRS-1
	or	or
	Victoreen Pancake GM - Model 489-110	Eberline Ratemeter - Model PRM-6
	Ludlum Proportional Floor Monitor - Model 239-1	Ludlum Scaler/Ratemeter - Model 2220
EXPOSURE RATE	Reuter Stokes Pressurized Ionization Chamber Model RSS-11	Same as Detector
	or	
	Victoreen NaI Scintillator - Model 489-55	Eberline Ratemeter - Model PRM-6
	or	
	Eberline Compensated G-M Detector - Model HP-270	Eberline Scaler/Ratemeter - Model PRS-1
SURFACE CONTAMINATION		
Beta-Gamma (Total)	Eberline Pancake GM - Model HP-260	Eberline Scaler/Ratemeter - Model PRS-1
Beta Smears (Removable)	Thin-Window Proportional Chamber	Tennelec Low Background Alpha-Beta Counter Model LB5110

APPENDIX B

INSTRUMENTATION FOR VERIFICATION MEASUREMENTS

Type Measurement	Detector[a]	Recording Instrument[a]
GAMMA SPECTROSCOPY	Princeton Gamma-Tech Ge(Li) Detector Model LGCC2220SD used in conjunction with: Applied Physical Technology Lead Shield Model SPG-16 EG&G ORTEC High-Purity Germanium Coaxial Well Detector - Model GWL-1102010-PWS-S used in conjunction with: Applied Physical Technology Lead Shield Model G-16 Princeton Gamma-Tech High-Purity Germanium Detector Model IGC25 used in conjunction with: Nuclear Data Lead Shield EG&G ORTEC High-Purity Germanium Detector Model GMX-23195-S used in conjunction with: Gamma Products, Inc. Lead Shield - Model G-16	All detectors used with: Nuclear Data Multichannel Analyzer Model ND-66 and one of the following data management systems: Nuclear Data Model ND-680 or Digital Electronic Corp. MicroVax II Model 630QB-A2

APPENDIX C

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX C

MEASUREMENT AND ANALYTICAL PROCEDURES

Surface Scans

Surface scans in the facility were performed by passing the probes slowly over the surface. The distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Beta-gamma scans of large surface areas on the floor of the facility were accomplished by use of a gas proportional floor monitor, with a 600 cm^2 sensitive area. The instrument was slowly moved in a systematic pattern to cover 100% of the accessible area. Combinations of detectors and instrument for the scans are given in Table 1 of this report.

Gamma Exposure Rate Measurements

Measurements of gamma exposure rates were performed using Eberline Model PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes, containing 3.2 cm x 3.8 cm NaI(Tl) scintillation probes or Eberline Model PRS1 scaler/ratemeter with Eberline Compensated GM Model HP-270. Count rates were converted to exposure rates (μR/h) by onsite cross-calibration with a Reuter-Stokes Model RSS-111 pressurized ionization chamber (PIC). Measurements of gamma exposure rates were also performed using the a Reuter-Stokes pressurized ionization chamber placed 1 meter above the surface.

Total Beta-Gamma Contamination Measurements

Measurements of total beta-gamma radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model HP-260 thin-window pancake GM probes. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for active area of the detector. The effective window area was 15 cm^2 and the average background count rate was approximately 40 cpm for the GM probes.

Removable Beta Contamination Measurements

Smears for determination of removable contamination levels were collected on numbered filter paper disks 47 mm in diameter, then placed in individually labeled envelopes with the location and other pertinent information recorded. The smears were counted on a low background gas proportional alpha-beta counter.

Soil Sample Analysis

Soil samples were dried, mixed, and a portion sealed in 0.5-liter Marinelli beaker. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry and typically ranged from 600 to 800 g of soil. Net soil weights were determined and the samples counted using intrinsic germanium and Ge(Li) detectors coupled to a Nuclear Data Model ND-680 pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

Co-60	1.173 MeV
Cs-137	0.662 MeV
Sb-125	0.428 MeV

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report, represent the 95% (2σ) confidence levels for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the (2σ) statistical deviation of the background count, the sample concentration was reported as less than the minimum detectable concentration

(<MDC). Because of variation in background levels and the effects of the Compton continuum caused by other radionuclides in the samples, the MDC's for specific radionuclides differ from sample to sample.

Calibration and Quality Assurance

Laboratory and field survey procedures are documented in manuals developed specifically for the Oak Ridge Associated Universities' Environmental Survey and Site Assessment Program.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NBS-traceable standards. The calibration procedures for the portable gamma instruments are performed by comparison with an NBS calibrated pressurized ionization chamber.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.