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REPORT

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on

ANNUAL SURVEY OF THE RETIRED PIQUA NUCLEAR POWER FACILITY

to

THE UNITED STATES DEPARTMENT OF ENERGY

January 1988

by

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prepared by

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ANNUAL SURVEY OF THE RETIRED PIQUA NUCLEAR POWER FACILITY

by

G. E. Kirsch

INTRODUCTION

The annual environmental radiological survey of the Retired Piqua Nuclear Power Facility was performed on November 10, 1987, by Battelle-Columbus. The radiation survey was performed on site and samples were collected for analyses at the Battelle West Jefferson radiochemistry laboratory. Samples collected included area smears to be counted for removable surface contamination, tap water, a sump water sample, a sump sludge sample, and soil samples from the ground area adjacent to the facility. Also, additional analyses were performed for these media as described in the survey specifications on page 13. In addition, smears, air samples, and water samples were collected and analyzed for tritium and are also described in the survey specifications. The analyses results indicate no significant change over past years' surveys and meet all criteria for release of the Piqua facility.

The specific survey parameters are as follows:

(1) Survey Instrumentation

All survey and monitoring results were identified listing types of monitoring instruments used, and calibration certification data for each instrument, including method of establishing calibration that is traceable to the National Bureau of Standards.

(2) Survey Specifications

The following describes the annual radiological survey and analysis of the Piqua Nuclear Power Facility performed since 1970. For the 1987 survey as mentioned above in the introduction, additional smear, air, and water samples were collected and analyzed. The specifications of the survey for 1987 are the same as surveillance activities performed in 1981, 1982, 1983, 1984, 1985, and 1986 with the exception of the optional surveys

performed in 1984 and 1987. The optional surveys performed in 1984 consisted of verifying the flow path of an effluent discharge point and analyzing samples of water and soil collected at the discharge point. Also, a sample of residual water was collected from a storage tank located in the auxiliary building and analyzed. The work performed in 1984 was required on a one-time basis only.

Surface Contamination

SMEAR SURVEY

Smear samples for transferrable contamination of the outer face of the reactor shielding wall at various levels below the main floor were collected. The survey consisted of sampling and monitoring points 22 through 78 as described in Exhibit I and as illustrated in Exhibits IIA, IIB, and IIC. The samples were counted for gross alpha and beta/gamma activity and reported in disintegrations per minute per 100 square centimeters (dpm/100 cm²). Smear samples for tritium are also described in Exhibit I and illustrated in Exhibit IIA, IIB, and IIC.

If the detected levels of contamination within a specific area averaged more than the levels shown in Exhibit III, an isotopic determination was to be performed, if possible, and a confirming follow-up survey of the area was to be performed as soon as possible. Also, for the survey for 1987, smears were collected and analyzed for concentrations of tritium present on various building surfaces.

RADIATION SURVEYS

Radiation surveys were performed on the outer face of the reactor shielding wall and at various levels below the main floor, specifically the numbered locations 22-78 as describe in Exhibit I and as illustrated in Exhibits IIA, IIB, and IIC. All radiation readings were reported in units of millirads per hour at 1 centimeter from the monitored surfaces. The survey instrument detector has no more than 7 milligrams per square centimeter of total absorber and was calibrated to conform with the Battelle Quality Assurance Program.

EXHIBIT I

SURVEY RESULTS

PNPF ANNUAL SMEAR AND RADIATION SURVEY REPORT

Survey Date November 10, 1987 Surveyors G.E. Kirsch and M.P. Failey
 Survey Instrument Eberline E-120 with HP-210 Probe I.D. No. 90430
 Smear Counting Date November 13, 1987 Counting Analyst M.J. Stenhouse
 Counting Instrument Tennelec LB-5100, I.D. No. X39265

Radiation Surveys - Surface Contamination

Location	Beta-Gamma Fixed (mrad/hr)	Removable Alpha (dpm/100 cm ²)				Removable Beta-Gamma (dpm/100 cm ²)			
		dpm		+/-2s		dpm		+/-2s	
<u>78'6" Level</u>									
22 Floor	<0.02	0.97	1.95	<MDA*	(alpha)	0.95	2.23	<MDA	(beta)
23 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	1.19	2.28	<MDA	(beta)
24 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	-0.23	1.96	<MDA	(beta)
25 Wall	<0.02	-0.48	0.97	<MDA	(alpha)	0.47	2.12	<MDA	(beta)
26 Wall	<0.02	1.46	2.18	<MDA	(alpha)	0.23	2.07	<MDA	(beta)
27 Wall	<0.02	-0.48	0.97	<MDA	(alpha)	0	2.02	<MDA	(beta)
28 Floor	<0.02	0.48	1.68	<MDA	(alpha)	1.42	2.33	<MDA	(beta)
29 Floor	<0.02	2.43	2.58	<MDA	(beta)	0	2.02		
30 Floor	<0.02	0	1.37	<MDA	(alpha)	1.90	2.42	<MDA	(beta)
31 Wall	<0.02	0.97	1.95	<MDA	(alpha)	0	2.02	<MDA	(beta)
32 Metal grating catwalk	<0.02	0.97	1.95	<MDA	(alpha)	0.95	2.23	<MDA	(beta)
33 Metal grating catwalk	<0.02	0	1.37	<MDA	(alpha)	1.19	2.28	<MDA	(beta)
34 Metal grating catwalk	<0.02	0.48	1.68	<MDA	(alpha)	0.71	2.18	<MDA	(beta)
35 Metal grating catwalk	<0.02	-0.48	0.97	<MDA	(alpha)	-0.23	1.96	<MDA	(beta)
36 Metal grating catwalk	<0.02	-0.48	0.97	<MDA	(alpha)	0.47	2.12	<MDA	(beta)

EXHIBIT I

SURVEY RESULTS

(Page 2)

Radiation Surveys - Surface Contamination

Location	Beta-Gamma Fixed (mrad/hr)	Removable Alpha (dpm/100 cm ²)			Removable Beta-Gamma (dpm/100 cm ²)		
		dpm		+/-2s	dpm		+/-2s
<u>78'6" Level (Continued)</u>							
37 Floor	<0.02	0.48	1.68	<MDA (alpha)	-0.47	1.90	<MDA (beta)
38 Stair	<0.02	-0.48	0.97	<MDA (alpha)	0.71	2.18	<MDA (beta)
39 Floor	<0.02	0.97	1.95	<MDA (alpha)	1.19	2.28	<MDA (beta)
40 Floor drain	<0.02	-0.48	0.97	<MDA (alpha)	0.47	2.12	<MDA (beta)
41 Floor drain	<0.02	0	1.37	<MDA (alpha)	-0.47	1.90	<MDA (beta)
42 Floor	<0.02	0.48	1.68	<MDA (alpha)	1.19	2.28	<MDA (beta)
43 Wall	<0.02	-0.48	0.97	<MDA (alpha)	-0.47	1.90	<MDA (beta)
44 Floor	<0.02	0	1.37	<MDA (alpha)	-0.23	1.96	<MDA (beta)
45 Floor	<0.02	-0.48	0.97	<MDA (alpha)	0.47	2.12	<MDA (beta)
46 Floor drain	<0.02	0.48	1.68	<MDA (alpha)	0.95	2.23	<MDA (beta)
47 Floor	<0.02	0	1.37	<MDA (alpha)	0	2.02	<MDA (beta)
48 Wall	<0.02	-0.48	0.97	<MDA (alpha)	-0.47	1.90	<MDA (beta)
49 Wall	<0.02	0	1.37	<MDA (alpha)	3.33	2.69	<MDA (beta)
50 Metal grating	<0.02	-0.48	0.97	<MDA (alpha)	-0.23	1.96	<MDA (beta)
51 Metal grating	<0.02	0	1.37	<MDA (alpha)	0.95	2.23	<MDA (beta)
52 Wall	<0.02	0.48	1.68	<MDA (alpha)	-0.47	1.90	<MDA (beta)
53 Exhaust air duct	<0.02	0	1.37	<MDA (alpha)	0.95	2.23	<MDA (beta)
54 Exhaust air duct	<0.02	0.48	1.68	<MDA (alpha)	0	2.02	<MDA (beta)
55 Metal grating	<0.02	-0.48	0.97	<MDA (alpha)	0.47	2.12	<MDA (beta)
56 Metal grating	<0.02	-0.48	0.97	<MDA (alpha)	1.42	2.33	<MDA (beta)
57 Metal grating	<0.02	0	1.37	<MDA (alpha)	0.23	2.07	<MDA (beta)
58 Metal grating	<0.02	1.46	2.18	<MDA (alpha)	0.95	2.23	<MDA (beta)
59 Metal grating	<0.02	0	1.37	<MDA (alpha)	0.95	2.23	<MDA (beta)
60 Metal grating	<0.02	0.48	0.97	<MDA (alpha)	0.71	2.18	<MDA (beta)

SURVEY RESULTS

(Page 3)

Radiation Surveys - Surface Contamination

Location	Beta-Gamma Fixed (mrad/hr)	Removable Alpha (dpm/100 cm ²)				Removable Beta-Gamma (dpm/100 cm ²)			
		dpm		+/-2s		dpm		+/-2s	
<u>78'6" Level (Continued)</u>									
61 Supply air duct	<0.02	0	1.37	<MDA	(alpha)	1.42	2.33	<MDA	(beta)
62 Emergency personnel air lock	<0.02	0.48	1.68	<MDA	(alpha)	2.14	2.47	<MDA	(beta)
63 Emergency personnel air lock	<0.02	0.48	1.68	<MDA	(alpha)	-0.71	1.84	<MDA	(beta)
<u>56'6" Level</u>									
64 Stairwell	<0.02	0.48	1.68	<MDA	(alpha)	1.42	2.33	<MDA	(beta)
65 Stairwell	<0.02	0	1.37	<MDA	(alpha)	0.23	2.07	<MDA	(beta)
66 Stairwell	<0.02	0	1.37	<MDA	(alpha)	0	2.02	<MDA	(beta)
67 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	-0.71	1.84	<MDA	(beta)
68 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	1.66	2.38	<MDA	(beta)
69 Floor	<0.02	0.48	1.68	<MDA	(alpha)	0.47	2.12	<MDA	(beta)
70 Wall	<0.02	-0.48	0.97	<MDA	(alpha)	0	2.02	<MDA	(beta)
71 Wall	<0.02	0.48	1.68	<MDA	(alpha)	0.47	2.12	<MDA	(beta)
72 Floor	<0.02	0.97	1.95	<MDA	(alpha)	0.95	2.23	<MDA	(beta)
73 Wall	<0.02	0	1.37	<MDA	(alpha)	1.66	2.38	<MDA	(beta)
74 Drain F4	<0.02	-0.48	0.97	<MDA	(alpha)	0.47	2.12	<MDA	(beta)
75 Floor	<0.02	0	1.37	<MDA	(alpha)	-0.23	1.96	<MDA	(beta)
76 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	0.47	2.12	<MDA	(beta)
77 Floor	<0.02	-0.48	0.97	<MDA	(alpha)	-0.71	2.18	<MDA	(beta)
78 Floor	<0.02	0.48	1.68	<MDA	(alpha)	0	2.02	<MDA	(beta)

SURVEY RESULTS

(Page 4)

PNPF ANNUAL SMEAR AND RADIATION SURVEY REPORT

Survey Date November 10, 1987 Surveyor M.P. Failey
 Counting Instrument Packard 2000CA Liquid Scintillation Analyzer I.D. No. 43365
 Smear Counting Date November 13, 1987 Counting Analyst M.P. Failey

Tritium Surveys

Location	Removable Tritium (dpm/100 cm ²)	Tritium in Air (pCi-L ⁻¹)
<u>78'6" Level</u>		
22 Wall	<7	<MDA
28 Wall	<7	<MDA
31 Wall	<7	<MDA
33 Under catwalk	<7	<MDA
43 Wall	<7	<MDA
49 Floor Cover	<7	<MDA
Six feet west of Location 53 by doorway		<0.10 <MDA

SURVEY RESULTS

(Page 5)

Tritium Surveys

Location	Removable Tritium (dpm/100 cm ²)	Tritium In Air (pCi-L ⁻¹)
<u>56'6" Level</u>		
67 Wall	<7	<MDA
67 Wall behind duct	<7	<MDA
72 Wall	<7	<MDA
73 Wall	<7	<MDA
74 Ventilation duct	<7	<MDA
77 Wall	<7	<MDA
Six feet west of Location 67 by doorway		<0.021 <MDA
<u>100' Level</u>		
Office wall within containment	<7	<MDA
Front office wall	<7	<MDA
South wall	<7	<MDA
West wall	<7	<MDA
North wall	<7	<MDA
East wall tool room	<7	<MDA
Three feet west of tool room		<0.017 <MDA

* <MDA = Less than minimum detectable activity

EXHIBIT IIA

PIQUA NUCLEAR POWER FACILITY REACTOR BUILDING

- EXHIBIT IIB

EXHIBIT IIC

PIQUA NUCLEAR POWER FACILITY REACTOR BUILDING

EXHIBIT III

ACCEPTABLE SURFACE CONTAMINATION LEVELS

(Reference U.S. NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors")

Nuclide(a)	Average(b,c)	Maximum(b,d)	Removable(b,e)
U-nat, U-235, U-238 and associated decay products	5000 dpm α /100 cm ²	15000 dpm α /100 cm ²	1000 dpm α /100 cm ²
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm ²	3000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5000 dpm $\beta\gamma$ /100 cm ²	15000 dpm $\beta\gamma$ /100 cm ²	1000 dpm $\beta\gamma$ /100 cm ²

- (a) Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.
- (b) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- (c) Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
- (d) The maximum contamination level applies to an area of not more than 100 cm².
- (e) The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent level should be reduced proportionally and the entire surface should be wiped.

Sump Water, Sludge, and Soil Samples

SUMP WATER AND SOLIDS

One water sample was collected from the lower level sump and analyzed for gross alpha and gross beta/gamma activity for both suspended and dissolved components. In addition, isotopic identification was performed for cesium-137, cobalt-60, tritium, strontium-90, and yttrium-90. A gamma spectral analysis was also performed.

FACILITY TAP WATER

One facility tap water sample was collected and analyzed for gross alpha, gross beta/gamma, strontium-90, and yttrium-90 activity in order to provide background comparison data with the sump water sample.

SUMP SOLIDS

One sump solids sample was collected from the lower level sump and analyzed for gross alpha and gross beta/gamma activity for both suspended and dissolved components. In addition, isotopic identification was performed for cesium-137, cobalt-60, strontium-90, and yttrium-90. A gamma spectral analysis was also performed.

ENVIRONMENTAL SURFACE/SOIL SAMPLES

Soil samples consisting of five 1-inch deep by 4-inch diameter plugs were collected from each of four 10-meter square areas located immediately outside the facility. The five samples were composited for each quadrant and analyzed for cesium-137, cobalt-60, strontium-90, and yttrium-90.

Visual Inspection

The entombed structure was examined to determine the occurrence of changes which might affect the integrity of structures and components. Photographs of any suspect areas were taken and provided in the final report.

A summary of the survey specifications with results is given in Table 1.

TABLE 1. SURVEY SPECIFICATIONS

Type	Location	Analyses Performed	Additional Requirements for 1987
I. Smear Survey	Locations 22-78	- Gross alpha and beta/gamma	- Gross alpha and tritium
Smear Survey	Locations (refer to to Exhibit 4C)	- Tritium	
Radiation Survey	Locations 22-78	- Beta/gamma radiation survey	
II. Water Sample "A"	Building Tap H ₂ O	- Gross alpha and beta (dissolved and suspended) - Strontium-90 and yttrium-90	- Strontium-90 and yttrium-90
Water Sample "B"	Lower Level Sump	- Gross alpha and beta (dissolved and suspended) - Strontium-90 and yttrium-90 - Gamma spectral including ¹³⁷ Cs and ⁶⁰ Co - Tritium	- Strontium-90 and yttrium-90 - Gamma spectral including ¹³⁷ Cs and ⁶⁰ Co - Tritium
Sludge Sample "B"	Lower Level Sump	- Gamma spectral including ¹³⁷ Cs, ⁶⁰ Co, strontium-90 and yttrium-90 - Gross alpha and gross beta/gamma	- Gamma spectral including ¹³⁷ Cs, ⁶⁰ Co, strontium-90 and yttrium-90 - Gross alpha
Five Environmental Surface/Soil Samples Each of Four Quadrants	Immediately Outside the Facility	- Gamma spectral including ¹³⁷ Cs and ⁶⁰ Co - Strontium-90 and yttrium-90	- Gamma spectral - Strontium-90 and yttrium-90
III. Visual Inspection	Outer Containment Vessel		

DISCUSSION AND RESULTS

Table 2 provides a listing of instruments used for survey and analysis, along with the date of calibration, the number of the Battelle Quality Assurance (QA) procedure used to calibrate the instrument, the source identification and certification number for the National Bureau of Standards traceability.

Surface Contamination

Removable surface contamination levels, as recorded in Exhibit I, were appreciably less than the criteria described in Exhibit III. The average level was less than the minimum detectable activity (MDA). Previous annual surveys indicated approximately the same levels of contamination.

Fixed surface contamination levels, as recorded in Exhibit I, were <0.02 mrad/hr at 1 cm for beta/gamma emitters. Previous annual surveys indicated essentially the same radiation levels.

Sump Water, Sludge, and Soil Samples

Refer to Table 3 (page 16) regarding water and sludge samples. Gross alpha and beta counting was performed on the water and sludge in the lower level sump (location B). For water, the alpha concentrations were $2.8 \pm 2.0 \times 10^{-9}$ and $<5 \times 10^{-9}$ $\mu\text{Ci/ml}$, respectively, for dissolved and solid components. The combined dissolved and solids alpha activity was $<8 \times 10^{-9}$ $\mu\text{Ci/ml}$ and the combined alpha activity for the year 1986 was $<3 \times 10^{-9}$ $\mu\text{Ci/ml}$. Combined alpha activity for samples collected prior to 1986 ranged from 1.0×10^{-9} to 4.0×10^{-8} $\mu\text{Ci/ml}$.

The beta concentrations in sump water for this survey were $4.9 \pm 0.2 \times 10^{-8}$ and $<1.0 \times 10^{-9}$ $\mu\text{Ci/ml}$, respectively, for dissolved and solid components. The combined dissolved and solids beta activity was $<5.0 \times 10^{-8}$ $\mu\text{Ci/ml}$. The combined beta activity for the survey performed in 1986 was $\sim 1 \times 10^{-7}$ $\mu\text{Ci/ml}$. Combined beta activity for samples collected prior to 1986 ranged from 1×10^{-8} to 1×10^{-7} $\mu\text{Ci/ml}$.

The total dissolved and solid alpha and beta gross activity in the sump water for the 1987 survey was $\sim 1.5 \times 10^{-8}$ $\mu\text{Ci/ml}$. The total for the previous survey performed in 1986 was $\sim 1 \times 10^{-7}$ $\mu\text{Ci/ml}$.

The sump water was also analyzed for cesium-137, cobalt-60, strontium-90, and yttrium-90. The total soluble and insoluble concentration of cesium-137 was $1.9 \pm 1.4 \times 10^{-8}$ $\mu\text{Ci/ml}$. The soluble concentration was $1.8 \pm 1.4 \times 10^{-8}$ $\mu\text{Ci/ml}$ and the insoluble was $<1 \times 10^{-9}$ $\mu\text{Ci/ml}$. The total concentration for the survey conducted in 1986 was $<1.5 \times 10^{-8}$ $\mu\text{Ci/ml}$ total, with the respective soluble and insoluble concentrations of $<1 \times 10^{-8}$ $\mu\text{Ci/ml}$ and 5×10^{-9} $\mu\text{Ci/ml}$.

TABLE 2. INSTRUMENTATION AND CALIBRATION

Instrument	Calibration Date	Sources/ID Standards	QA Procedure
Tennelec LB5100 Series 2 Automatic Counting System	11-13-87	Sr-90/Y-90 Analytics, Inc. SRS 15886-84	HL-PP-248 Revision 1 HL-PP-98 Revision 0
		Sr-90/Y-90 IPL #8521-20	
		Pu-239 Eberline S-1868	
PGT Intrinsic Germanium Detector Nuclear Data 680 Gamma Spectrometer	11-13-87	Mixed Gamma Std. NES-602, New England Nuclear	HL-PP-248.1 Revision 1 HL-PP-98 Revision 0
		Mixed Gamma Std. NBS/SRM4276B	
Eberline E-120 with HP-210 Probe ID No. X90430	9-03-87	Ra-226 HP14 NBS No. 26812	IL-CP-129 Revision 1
Packard 2002 CA Liquid Scintillation Analyzer ID No. X43365	11-13-87	Tritium Quench Series NES-203	HL-PP-120.1 Revision 0

TABLE 3. WATER, SLUDGE AND SOIL SAMPLES*
($\pm 1\sigma$ for water; $\pm 2\sigma$ for solids)

Identification and Location	Dissolved Alpha	Solids Alpha	Dissolved Beta	Solids Beta	Dissolved Cs-137	Solids Cs-137	Dissolved Co-60	Solids Co-60	Dissolved Sr-90 & Y-90	Solids Sr-90 & Y-90	Gamma Spectral	Tritium
Sample A - Bldg. Tap Water	$2.6 \pm 1.6 \times 10^{-9}$	$< 6 \times 10^{-10}$	$4.2 \pm 0.8 \times 10^{-9}$	$< 1 \times 10^{-9}$	--	--	--	--	$< 1.2 \times 10^{-9}$	$< 1 \times 10^{-9}$	--	--
Sample B - Lower Level Sump Water	$2.8 \pm 2.0 \times 10^{-9}$	$< 6 \times 10^{-9}$	$4.9 \pm 0.2 \times 10^{-8}$	$< 1 \times 10^{-9}$	$1.8 \pm 1.4 \times 10^{-8}$	$< 1.0 \times 10^{-9}$	$< 3.2 \times 10^{-8}$	$< 1 \times 10^{-9}$	$< 1.3 \times 10^{-9}$	$< 1 \times 10^{-9}$	All <MDA except Cs-137	$< 5.6 \times 10^{-7}$ (MDA)
Sample B - Lower Level Sump Sludge	--	--	--	--	--	94 ± 5	--	29 ± 2	--	0.087	All <MDA except Cs-137 and Co-60	--
North Quadrant Soil	--	--	--	--	--	0.46 ± 0.09	--	<MDA	--	< 0.041	All <MDA except Cs-137	--
South Quadrant Soil	--	--	--	--	--	0.2 ± 0.08	--	<MDA	--	< 0.098	All <MDA except Cs-137	--
East Quadrant Soil	--	--	--	--	--	0.34 ± 0.12	--	<MDA	--	< 0.076	All <MDA except Cs-137	--
West Quadrant Soil	--	--	--	--	--	0.014 ± 0.008	--	<MDA	--	< 0.061	All <MDA except Cs-137	--

* Concentrations are reported as pCi/ml for water samples and pCi/gram for sludge and soil samples.

< Less than minimum detectable activity (MDA)

The cobalt-60 total concentration for 1987 was $<3.3 \times 10^{-8}$ with the respective soluble and insoluble concentrations of $<3.2 \times 10^{-8} \mu\text{Ci/ml}$ and $<1 \times 10^{-9} \mu\text{Ci/ml}$. For the 1986 survey, the total concentration was $<3.0 \times 10^{-8} \mu\text{Ci/ml}$ and the respective soluble and insoluble concentrations were $<2.0 \times 10^{-8} \mu\text{Ci/ml}$ and $<1.0 \times 10^{-8} \mu\text{Ci/ml}$.

Analyses for strontium-90 and yttrium-90 were performed on an initial basis for this survey. The total concentration was $<2.3 \times 10^{-9} \mu\text{Ci/ml}$ with the respective soluble and insoluble concentrations of $<1.3 \times 10^{-9}$ and $<1 \times 10^{-9} \mu\text{Ci/ml}$.

The two graphs on pages 18 and 19 illustrate the cesium-137 and cobalt-60 activity in sump liquids and solids for the 11 year period 1977 through 1987.

Comparison of Concentrations of Activity of Water in
the Sump with the Concentration Guides Listed in
DOE Order 5480.1 Chapter XI

Where either the identity or the concentration of any radionuclide in the mixture is not known, the concentration guide is $4 \times 10^{-7} \mu\text{Ci/ml}$ for a controlled area. The total soluble and insoluble alpha and beta concentration of $\sim 6 \times 10^{-8} \mu\text{Ci/ml}$ for the sump water for 1987 is approximately 15 percent of the controlled area concentration guide.

From January 3, 1987 through December 31, 1987, no water was pumped from the reactor building (pump P-17) to the auxiliary building (pump P-18). Consequently for calendar year 1987, there were no releases recorded for reactor building sump water to the Great Miami River.

The respective concentration guides for soluble and insoluble cesium-137 for controlled areas are $4.0 \times 10^{-4} \mu\text{Ci/ml}$ and $1.0 \times 10^{-3} \mu\text{Ci/ml}$. The concentrations of cesium in the sump water for 1987 were $1.8 \pm 1.4 \mu\text{Ci/ml}$ and $<1 \times 10^{-9}$, respectively, for soluble and insoluble cesium-137.

Cobalt-60 was not detected above background levels, $<3.2 \times 10^{-8}$ and $<1 \times 10^{-9} \mu\text{Ci/ml}$, respectively, for the dissolved and solids components. The soluble and insoluble concentration guide for releases to controlled areas is $1 \times 10^{-3} \mu\text{Ci/ml}$.

Strontium-90 and yttrium-90 were not detected above background levels, $<1.3 \times 10^{-9}$ and $<1 \times 10^{-9} \mu\text{Ci/ml}$, respectively, for the dissolved and solids components. The respective soluble and insoluble concentration guides for releases to controlled areas are 1×10^{-5} and $1 \times 10^{-3} \mu\text{Ci/ml}$ for strontium-90. The guide for both soluble and insoluble yttrium-90 is $6 \times 10^{-4} \mu\text{Ci/ml}$.

Solids in the sludge contained in the sump were analyzed for gross alpha, gross beta, cesium-137, cobalt-60, strontium-90, and yttrium-90. The

GRAPH I
ACTIVITY IN SUMP WATER BY YEAR

GRAPH II
ACTIVITY OF SOLIDS IN SUMP SLUDGE BY YEAR

respective gross alpha and beta concentrations were 16 ± 5 and 93 ± 4 pCi/gram. The respective concentrations reported for 1986 were 5 ± 2 and 121 ± 6 pCi/gram. Cesium-137 was 94 ± 5 pCi/gram and cobalt-60 was 29 ± 2 pCi/gram. Respective results for 1986 for both radionuclides were 27.8 ± 6.6 pCi/gram for cesium-137 and less than 10 and greater than 7 pCi/gram for cobalt-60. Other gamma emitting radionuclides were not detected for the 1987 survey. Concentrations of strontium-90 and yttrium-90 were less than 0.087 pCi/gram. Strontium-90 and yttrium-90 analyses were not performed for sump media in association with previous routine annual surveys.

Surface Soil Samples

Refer to Table 3 (page 16) and Exhibit IV (page 21) regarding soil samples. Quadrants designated north, south, east, and west were sampled. Each quadrant consisted of a 10 meter by 10 meter square area adjacent to the facility, with the exception of the west quadrant which was paved and required moving outside the paved area to get the samples (see Exhibit IV). Five 2-inch deep by 4 inch diameter plugs of vegetation and soil were collected from each quadrant. A composite of each quadrant was analyzed for cesium-137, cobalt-60, strontium-90, and yttrium-90.

The concentrations reported for cesium-137 ranged from 0.014 ± 0.008 to 0.46 ± 0.09 pCi/gram. The concentrations for cesium-137 for the survey conducted in 1986 ranged from 0.04 ± 0.01 pCi/gram to 0.68 ± 0.03 pCi/gram. The cobalt-60 concentrations for 1987 were <0.05 pCi/gram.

The concentrations of cesium-137 and cobalt-60 in the soil for the other surveys conducted in 1981-1987 were compared with local background and with data obtained from the literature for a number of national background locations sampled in 1979.

The concentrations for the survey conducted in 1979 at the continental background locations ranged from 0.4 to 1.1 pCi/gram for cesium-137. Cobalt-60 ranged from 0.004 to 0.009 pCi/gram in the top 2 cm (0.8 in.) of soil.

The local concentrations of cesium-137 for the years 1979, 1980, and 1981 ranged from 0.24 to 0.84 pCi/gram. Cobalt-60 was reported only for 1979. The concentrations ranged from 0.4 to 2.2 pCi/gram.

The soil samples were also analyzed for strontium-90 and yttrium-90 on an initial basis. The concentrations were at their respective minimum detectable activity (MDA) of <0.041 to 0.098 pCi/gram.

The two graphs on pages 22 and 23 illustrate the cesium-137 and cobalt-60 activity in surface soil samples for the 7 year period 1981 through 1987.

EXHIBIT IV
SOIL SURVEY MAP

GRAPH III

CESIUM-137 ACTIVITY IN TOP 1 INCH OF SOIL BY YEAR
7 YEAR PERIOD: FROM INCEPTION 1981 TO 1987

NOTE for 1986: East and West Quadrants Not Illustrated.
Other Two Quadrants Sampled Were
Northeast and Southeast.

GRAPH IV

COBALT-60 ACTIVITY IN TOP 1 INCH OF SOIL BY YEAR
7 YEAR PERIOD: FROM INCEPTION 1981 TO 1987

NOTE for 1986: East and West Quadrants Not Illustrated.
Other Two Quadrants Sampled Were
Northeast and Southeast.

Visual Inspection

The outer containment vessel was visually examined for indications of changes in the integrity of the structure and components. No evidence of structural changes were observed.

CONCLUSIONS

The survey did not reveal the existence of any significant changes within the facility. Smears collected for removable alpha and beta-gamma surface contamination were all less than the respective minimum detectable levels of 0.97 ± 1.95 alpha and 1.90 ± 2.42 beta DPM/100 cm². All beta-gamma radiation readings for fixed contamination levels were less than 0.02 mrad/hr at 1 cm. Liquid and solid components in the sump were analyzed for gross alpha-beta and specific gamma emitters. Results compared with previous years' data. New for this survey was the inclusion of analyses of tap water, sump media and soil for strontium-90 and yttrium-90. All strontium-90 and yttrium-90 data were at their respective minimum detectable activities. Also, all of the preceding media were analyzed for gamma emitters other than cesium-137 and cobalt-60. No other gammas except cesium and cobalt were observed.

Also new for this survey was the inclusion of tritium analyses of smears, air samples, and sump water. In all instances, tritium was not observed in concentrations greater than the respective minimum detectable activities.

RECOMMENDATIONS

Since strontium-90, yttrium-90, and tritium were not observed in concentrations greater than their minimum detectable activities in water sludge and soil, it is recommended that they not be performed for the survey for 1988.