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Lifetime Retention



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TO: R.W. TAYLOR

FROM: W.G. WINN WGW

February 22, 1989

# Radioactive Effluents in Savannah River
# Summary Report for 1988

(Cover Sheet)

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## Introduction

During 1988, low-level radiometric studies of the Savannah River continued to distinguish between effluent contributions from Plant Vogtle and the Savannah River Plant. Measurements for radioactive effluents are of mutual benefit to both plants, as they can identify disturbing trends before they become health and legal concerns.

The Environmental Technology Division conducted radiometric environmental studies of Plant Vogtle prior to its startup in April, 1987 [ref 1]. Subsequent studies in 1987 identified neutron-activated radioisotopes in the Savannah River caused by controlled releases from Vogtle in May and October [ref 2]. The present work continues to monitor these radioisotopes in the 1988 releases at comparable activity levels. The largest isotopic activity was Co-58. However, all isotopic activities were several orders of magnitude below DOE guide values [ref 3]. The ETD river measurements agree with effluent release information provided by Vogtle.

ETD ultra low-level radiometric measurement techniques are used in this work. In general, river samples are concentrated on resins, prepared in the lab, and then counted in the Underground Counting Facility at 735-A [ref 4]. The bulk of the counting utilizes gamma-ray spectroscopy. Tritium is examined by liquid scintillation counting. The overall sampling/counting technique for gamma-ray analysis provides detection limits that are thousands of times lower than those routinely achievable. Tritium analysis also utilizes state-of-the-art detection sensitivity. An underwater NaI(Tl) detector at Hwy 301 Bridge has become useful for continuous monitoring of the Savannah River.

## Summary

During 1988, radioactive effluents in the Savannah River continued to correlate with Vogtle operations. All radionuclide concentrations remained well below DOE guides for drinking water. The Vogtle effluents were dominated by Co-58, which had a maximum concentration of 15.5 pCi/L observed during a controlled release in October. Smaller amounts of Cr-51, Mn-54, Co-57, Fe-59, Co-60, Nb-95, and Zr-95 were also observed in the effluents. The underwater NaI(Tl) detector at Hwy 301 bridge also monitored the Co-58 activity, which tracked well with the resin concentrator measurements. Tritium and Cs-137 were routinely monitored but continued to remain at levels attributable to known SRP sources.

## River Sampling

Samples were collected from the Savannah River at Shell Bluff, near the Vogtle outfall, and at Hwy 301 bridge. The increase in activity from Shell Bluff to 301 bridge is due to effluents from both Vogtle and SRP. Activities measured just upstream and downstream of the Vogtle outfall identify contributions from that plant alone. Specifically, samples were taken 0.3 mi above, 0.1 mi below, and at the Vogtle outfall.

Three types of samples were collected - resin, water, and sediment. Each resin concentrator sample consists of ~25 g of resin in a porous nylon bag. The samplers were in the river for two weeks, after which they were retrieved and returned to the lab. Water samples were collected directly, and sediment samples were scooped into a specially designed sampler pulled along the bottom of the river. These methods are detailed further in the Vogtle pre-startup study [ref 1].

## Laboratory Measurements

The resin concentrator sample measurements provide the most comprehensive isotopic information. Each of these samples was dried and ashed, leaving a smaller volume and thus better sample geometry for the HPGe detector. Two HPGe detectors with Co-60 standard efficiency of ~25% were used in counting these samples; both are located in the Underground Counting Facility. Samples were counted overnight (or over the weekend) to assure good counting statistics for detecting low-level activities. The resulting HPGe gamma-ray spectra are analyzed with an on-line IBM/PC-XT using the GRABGAM code [ref 4], to yield the activity (fCi) of each isotope detected in the resin sample. The average isotopic concentration (fCi/L) for the river collection period is obtained by using empirical calibration data that relate the resin mass and collection time to the effective water volume (L).

The water samples were examined for tritium by liquid scintillation. A TRICARB LL 2050A low-level liquid scintillation counter was used. Vials with 3 mL of sample and 20 mL of REDISOLV(R) or OPTI-FLUOR™ scintillant were counted. Duplicate samples with 0.25 mL of tritium standard checked that the automatic quench corrections were being performed accurately.

Sediment samples were transferred to 1-liter Marinelli beakers and then counted on the HPGe detectors as described above. The sample isotopic activities (fCi) from the gamma-ray analysis are divided by the dry weight (g) of each sample to yield the corresponding concentrations (fCi/g).

## Underwater NaI(Tl) Measurements

The underwater NaI(Tl) detector operates from a stationary pontoon boat near Hwy 301 bridge. The detector includes a 9" diam by 4" long NaI(Tl) crystal, four photo-multiplier tubes, and high voltage/preamp unit, all being contained within a waterproof stainless steel housing. The detector views its surroundings through a thin hemispherical dome.

The detector receives operating power via a waterproof cable connected to a ~25 V DC supply in the cabin of the pontoon boat. The same cable transmits the detector pulses to an amplifier in the cabin. The amplified pulses are then input to a mulitchannel analyzer comprised of a COMPAQ 286 computer with an ACE MCA card from EG&G ORTEC.

Spectral data are counted and stored on floppy disk in sequenced 24-hr periods for 2-3 weeks. The disks are retrieved and analyzed at the laboratory. This detector system provides better time resolution (1 day) than the resin concentrator method (2 weeks). The detector has a Co-58 sensitivity of ~100 fCi/L, compared to the resin concentrator method, which has a sensitivity of ~10 fCi/L.

## Results

The resin sampler analysis continued to indicate Co-58, Co-60, and Cs-137, the most significant gamma-emitting radionuclides detected in the earlier studies [ref 1,2]. The 1988 results for these isotopes are given in Tables 1-3, along with plots in Figures 1-3. The other man-made radionuclides correlate with the Co-58, and are included in Table 4.

Water analysis for tritium followed techniques used earlier [ref 1,2]. The 1988 tritium results are summarized in Table 5.

Sediments were analyzed for Co-58, Co-60, and Cs-137 to appraise whether any deposition is occuring during the transport of these isotopes in the river water. The corresponding results are shown in Table 6.

Data for the underwater NaI(Tl) detector are given in Figures 4 and 5. Figure 4 is an isometric plot of countrate vs gamma energy and date; it includes insets that define the detected isotopes and display Co-58 tracking of resin concentrator samples. Figure 5 provides a more quantitative comparison of the Co-58 tracked by the two methods. The data include underwater detector measurements since beginning in July 1987 through 1988.

## Discussion

The 1988 river concentrations for H-3, Co-60, and Cs-137 continue to show overall consistency with the pre-startup values taken in early 1987. In 1988, the average tritium was 2.9 pCi/mL at Hwy 301 Bridge [Table 5], which is in excellent agereement with the 3.0 pCi/mL measured prior to Vogtle startup [ref 2]; tritium measurements at the other river locations have remained at ~ 2 pCi/mL. All increases in Co-60 [Table 2/Figure 2] continue to track well with the principal gamma activity Co-58 [Table 1/Figure 1], and have been positively correlated with Vogtle releases [ref 2]. In 1988, a maximum Co-60 concentration of 489 fCi/L was observed 0.1 mile downstream of Vogtle. This is somewhat higher than the maximum of 146 fCi/L observed in 1987 and is apparently due to longer neutron activation buildup. However, Table 2 illustrates that these Co-60 levels drop to pre-startup values below 9 fCi/L during periods when Vogtle releases are minimal, indicating that no lasting accumulation of Co-60 is caused by these releases. By contrast, the Cs-137 [Table 3/Figure 3] does not strongly correlate with the Vogtle releases, but is more consistent with earlier observations concerning effluents from SRP. The largest Cs-137 activities were observed at Hwy 301 bridge, at levels of ~100 fCi/L. This is well understood from earlier SRP studies [ref 6]. Activities near Vogtle do not imply any significant Cs-137 from its releases. The levels are in general agreement with the ~ 15 fCi/L measured prior to startup. (A outlier of 49 fCi/L measured 0.1 mile downstream of Vogtle is noted, but it does not correlate with the Co-58 release date-profiles). The overall Cs-137 is known to be associated with surface runoff from SRP flood plains [ref 6].

The Co-58 concentrations [Table 1/Figure 1] continue to provide the most sensitive correlation with Vogtle effluents. The largest Co-58 concentrations were just downstream of Vogtle, with a maximum observed 15,500 fCi/L during October. By contrast, typical pre-startup levels were below 10 fCi/L.

A number of other isotopes [Table 4] detected along with Co-58 also correlated with the Vogtle releases. These isotopes are Cr-51, Mn-54, Co-57, Fe-59, Co-60, Nb-95, and Zr-95. Like Co-58, all these are due to neutron activation of metals within the coolant and moderator systems of the reactor [ref 7,8]. These same radionuclides were also detected in the 1987 releases, and their relative isotopics agreed well with Vogtle release data [ref 2].

The 1988 sediment results [Table 6] show some buildup over the levels observed in 1987; however, the levels have remained relatively constant during the year. Just below Vogtle, the Co-58 in 1988 averaged 68 fCi/g, which is significantly larger than the 16 fCi/g maximum observed in 1987. The 1987 sediment samples were taken prior to the largest release in October of that year. The 1988 samples include the effect of such earlier releases as well as later ones. The corresponding increase for Co-60 is barely discernable, and the other released isotopes were below detection levels. Cs-137 remained at the ~10 fCi/g levels observed earlier.

The underwater NaI(Tl) results indicate that near real-time monitoring may be a prospect for the future. The Co-58 monitored with this detector tracks well with the Co-58 detected in the nearby resin samples, as shown in Figures 4 and 5. In Figure 5, an exception to this tracking appears to exist in early February of 1988, where Co-58 was detected by the resin sampler but the underwater detector shows no Co-58 detected. However, the underwater detector was not functioning during this period, as evidenced by the lack of a total rate in Figure 4. A remote data retrieval system (e.g. modem, radio, or satellite) is being considered to allow quicker response to both operational concerns and monitoring trends.

Excluding the Vogtle releases, the increases of radioactive concentrations from Shell Bluff to Hwy 301 Bridge are consistent with those measured in previous years [refs 2,5]. In the present work, Cs-137 was the only man-made gamma activity that was clearly detected from SRP sources [Table 3/Figure 3]. An SRP contribution of ~1 fCi/L Co-60 [ref 1] is now totally dominated by typical Vogtle contributions of ~100 fCi/L Co-60.

Finally, the release data should be put in perspective relative to DOE guide limits for drinking water. Table 7 compares these guide levels with the maximum Vogtle concentrations measured in the present study. All values are well below the DOE guides.

## Continuation of Study

These studies are continuing on a routine basis, as they allow early detection/correction of disturbing trends before actual health concerns evolve. The results are of mutual benefits to both Vogtle and SRP, and cooperative efforts between the two plants continue to enhance the measurements program. Annual reports on this work will continue; however, any significant aberrations in routine trends will be reported immediately.

Acknowledgements

Donald Hallman of Plant Vogtle continues to provide information on their releases. D.W. Hayes has now extended his Cs-137 program to provide routine backup data on the release isotopes. M.V. Kantelo has assured timely laboratory preparation/processing of the resin samples. C.D. Ouzts has coordinated the river sampling and has counted and analyzed the bulk of the samples.

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Table 1. Co-58 Concentrations in 1988

(Values in fCi/L)[a]

| Date | Plot X | Shell Bluff fCi/L | Above Vogtle fCi/L | Below Vogtle fCi/L | H301 Bridge fCi/L |
|---|---|---|---|---|---|
| 12/3-12/16 | | -8.04 | -9.28 | 2503.33 | 38.74 |
| 12/16-1/12 | 12/29 | -5.72 | -3.57 | 1403.51 | 80.09 |
| 1/12-1/29 | | -5.26 | -5.56 | 2905.38 | 130.05 |
| 1/29-2/11 | 2/4 | -11.50 | -7.47 | 13964.42 | 1093.79 |
| 2/11-2/25 | | -7.79 | -6.90 | 5955.06 | 416.89 |
| 2/25-3/10 | 3/3 | -2.45 | -5.98 | 4683.78 | 605.46 |
| 3/10-/24 | | -2.88 | -5.74 | 1102.96 | 72.07 |
| 3/24-4/7 | 3/31 | -5.74 | -5.15 | 587.82 | 92.13 |
| 4/7-4/21 | | -4.64 | -2.80 | 187.67 | 49.94 |
| 4/21-5/5 | 4/28 | -4.01 | -9.40 | 1828.99 | 94.74 |
| 5/5-5/19 | | -5.93 | -6.49 | 374.32 | 44.22 |
| 5/19-6/2 | 5/26 | -2.86 | -9.44 | 241.08 | 57.88 |
| 6/2-6/16 | | -3.81 | -7.14 | 111.95 | 18.07 |
| 6/16-6/29 | 6/23 | -9.55 | -14.19 | 56.83 | 69.65 |
| 6/29-7/14 | | -5.19 | -8.26 | 60.18 | -3.68 |
| 7/14-7/28 | 7/21 | -2.09 | -2.96 | 63.16 | 5.75 |
| 7/28-8/11 | | -2.14 | -1.84 | 662.49 | 17.40 |
| 8/11-8/25 | 8/18 | -4.02 | -6.16 | 288.52 | 13.61 |
| 8/25-9/08 | | -3.31 | -4.97 | 167.12 | 19.72 |
| 9/08-9/22 | 9/15 | -3.73 | -13.91 | 130.86 | 14.87 |
| 9/22-10/6 | | -4.51 | -3.92 | 1316.27 | 65.45 |
| 10/6-10/20 | 10/13 | -5.37 | -2.55 | 15494.17 | 322.70 |
| 10/20-11/03 | | -5.00 | -4.45 | 3642.53 | 488.24 |
| 11/03-11/17 | 11/10 | -1.71 | -4.33 | 653.44 | 65.46 |
| 11/17-12/01 | | -3.69 | -6.29 | 4071.95 | 276.46 |
| 12/1-12/14 | 12/8 | -3.26 | -3.91 | 2814.35 | 153.79 |
| 12/14-1/5/89 | | -2.48 | -1.96 | 3897.07 | 443.40 |

(a) Counting error estimated at $\leq 0.82\sqrt{V}$ where V is entry value. Values with minus (-) are minimum detectable amounts (MDAs).

Table 2. Co-60 Concentrations in 1988

(Values in fCi/L)[a]

| Date | Plot X | Shell Bluff fCi/L | Above Vogtle fCi/L | Below Vogtle fCi/L | H301 Bridge fCi/L |
|---|---|---|---|---|---|
| 12/3-12/16 | | -6.80 | -6.70 | 42.10 | -7.60 |
| 12/16-1/12 | 12/29 | -4.30 | -3.60 | 22.30 | -9.30 |
| 1/12-1/29 | | -4.90 | -5.30 | 46.60 | -6.60 |
| 1/29-2/11 | 2/4 | -8.70 | -5.70 | 488.80 | 48.60 |
| 2/11-2/25 | | -5.50 | 5.70 | 210.30 | 18.50 |
| 2/25-3/10 | 3/3 | -2.30 | 5.60 | 173.70 | 24.70 |
| 3/10-/24 | | -2.60 | -5.50 | 64.30 | -7.30 |
| 3/24-4/7 | 3/31 | -4.90 | -4.90 | 32.00 | -8.10 |
| 4/7-4/21 | | -4.30 | -2.60 | 10.60 | -7.90 |
| 4/21-5/5 | 4/28 | -2.80 | -6.30 | 161.30 | -13.50 |
| 5/5-5/19 | | -5.20 | -5.50 | 22.50 | -7.80 |
| 5/19-6/2 | 5/26 | -2.60 | -9.30 | 20.20 | 10.20 |
| 6/2-6/16 | | -3.20 | -7.10 | 11.40 | -8.70 |
| 6/16-6/29 | 6/23 | -8.10 | -11.00 | 10.20 | -13.50 |
| 6/29-7/14 | | -5.30 | -8.10 | -7.30 | -3.30 |
| 7/14-7/28 | 7/21 | -1.70 | -2.90 | 7.40 | -3.80 |
| 7/28-8/11 | | -2.00 | -1.80 | 151.20 | 7.10 |
| 8/11-8/25 | 8/18 | -3.80 | -5.50 | 69.50 | -5.10 |
| 8/25-9/08 | | -2.90 | -4.20 | 57.20 | 10.80 |
| 9/08-9/22 | 9/15 | -3.70 | -13.90 | 26.60 | 7.60 |
| 9/22-10/6 | | -3.70 | -3.40 | 163.40 | 10.40 |
| 10/6-10/20 | 10/13 | -4.90 | -2.40 | 324.80 | 13.80 |
| 10/20-11/03 | | -2.90 | -3.90 | 201.00 | 35.10 |
| 11/03-11/17 | 11/10 | -1.50 | -4.10 | 23.50 | 6.00 |
| 11/17-12/01 | | -3.20 | -5.80 | 272.40 | 19.50 |
| 12/1-12/14 | 12/8 | -2.50 | -3.30 | 249.00 | 17.00 |
| 12/14-1/5/89 | | -2.00 | -1.60 | 225.50 | 46.90 |

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(a) Counting error estimated at $\leq 0.75\sqrt{V}$ where V is entry value. Values with minus (-) are minimum detectable amounts (MDAs).

Table 3. Cs-137 Concentrations in 1988

(Values in fCi/L)[a]

| Date | Plot X | Shell Bluff fCi/L | Above Vogtle fCi/L | Below Vogtle fCi/L | H301 Bridge fCi/L |
|---|---|---|---|---|---|
| 12/3-12/16 | | 3.88 | -4.31 | 17.83 | 37.12 |
| 12/16-1/12 | 12/29 | -3.32 | 5.86 | 8.44 | 43.95 |
| 1/12-1/29 | | -2.62 | -1.35 | 9.43 | 71.79 |
| 1/29-2/11 | 2/4 | 6.39 | 2.73 | -14.41 | 70.80 |
| 2/11-2/25 | | -3.35 | 3.99 | 14.59 | 60.63 |
| 2/25-3/10 | 3/3 | 2.12 | -3.14 | -8.55 | 385.57 |
| 3/10-/24 | | 5.25 | -3.77 | 5.64 | 49.50 |
| 3/24-4/7 | 3/31 | -2.68 | 4.38 | -3.58 | 62.77 |
| 4/7-4/21 | | -2.37 | 5.36 | 5.64 | 57.29 |
| 4/21-5/5 | 4/28 | 3.46 | -4.12 | 19.16 | 67.28 |
| 5/5-5/19 | | -2.83 | 5.43 | 5.67 | 42.48 |
| 5/19-6/2 | 5/26 | 4.66 | 13.15 | 9.93 | 173.09 |
| 6/2-6/16 | | 4.79 | -4.38 | 6.40 | 101.95 |
| 6/16-6/29 | 6/23 | 11.83 | 15.32 | 8.65 | 185.22 |
| 6/29-7/14 | | -3.21 | -2.58 | 8.25 | 55.66 |
| 7/14-7/28 | 7/21 | 2.65 | 4.62 | 7.20 | 78.89 |
| 7/28-8/11 | | 3.74 | 2.95 | 19.87 | 52.92 |
| 8/11-8/25 | 8/18 | 9.24 | 13.53 | 22.28 | 125.77 |
| 8/25-9/08 | | 12.18 | 12.93 | 49.37 | 157.83 |
| 9/08-9/22 | 9/15 | 9.80 | 28.24 | 9.59 | 110.69 |
| 9/22-10/6 | | 10.97 | 4.18 | 11.13 | 75.48 |
| 10/6-10/20 | 10/13 | 11.86 | 10.46 | 28.02 | 55.37 |
| 10/20-11/03 | | 9.75 | 8.19 | 19.04 | 53.13 |
| 11/03-11/17 | 11/10 | 6.47 | 4.31 | 9.11 | 47.66 |
| 11/17-12/01 | | 3.23 | 13.12 | 9.75 | 37.80 |
| 12/1-12/14 | 12/8 | 4.64 | 5.25 | -6.25 | 28.55 |
| 12/14-1/5/89 | | 3.10 | 4.45 | 11.86 | 56.44 |

(a) Counting error estimated at $\leq 0.58\sqrt{V}$ where V is entry value. Values with minus (-) are minimum detectable amounts (MDAs).

Table 4. Relative Isotopics Below Vogtle During 1988[a]

| Date | Plot X | Co-58 | Isotopics X of Co-58 Activity below Vogtle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | fCi/L | Cr-51 | Mn-54 | Co-57 | Co-58 | Fe-59 | Co-60 | Nb-95 | Zr-95 | Cs-137 |
| 12/3-12/16 | | 2503.33 | | 0.89 | | 100.00 | | 1.68 | | | 1.43 |
| 12/16-1/12 | 12/29 | 1403.51 | | 0.82 | | 100.00 | | 1.59 | | | 1.20 |
| 1/12-1/29 | | 2905.38 | 6.62 | 1.21 | 0.22 | 100.00 | 0.70 | 2.27 | 1.13 | 0.75 | 0.90 |
| 1/29-2/11 | 2/4 | 13964.42 | 20.19 | 2.83 | 0.15 | 100.00 | 1.59 | 3.50 | 3.60 | 1.65 | |
| 2/11-2/25 | | 5955.06 | 14.22 | 2.73 | 0.15 | 100.00 | 1.31 | 3.51 | 2.15 | 1.16 | 0.48 |
| 2/25-3/10 | 3/3 | 4683.78 | 16.68 | 3.24 | | 100.00 | 1.41 | 3.71 | 2.51 | 1.54 | |
| 3/10-/24 | | 1102.96 | 24.78 | 3.46 | | 100.00 | 2.56 | 5.83 | | | 1.00 |
| 3/24-4/7 | 3/31 | 587.82 | | 4.13 | | 100.00 | | 5.44 | | | |
| 4/7-4/21 | | 187.67 | | | | 100.00 | | 5.65 | | | 6.12 |
| 4/21-5/5 | 4/28 | 1828.99 | 10.50 | 6.78 | | 100.00 | 2.15 | 8.82 | 5.76 | 2.40 | 2.05 |
| 5/5-5/19 | | 374.32 | | 4.51 | | 100.00 | | 6.01 | 4.11 | 3.56 | 2.96 |
| 5/19-6/2 | 5/26 | 241.08 | | 7.82 | | 100.00 | | 8.39 | | | 8.06 |
| 6/2-6/16 | | 111.95 | | 7.83 | | 100.00 | | 10.19 | | | 10.93 |
| 6/16-6/29 | 6/23 | 56.83 | | 7.95 | | 100.00 | | 17.88 | | | 28.48 |
| 6/29-7/14 | | 60.18 | | 5.85 | | 100.00 | | | | | 26.34 |
| 7/14-7/28 | 7/21 | 63.16 | | 10.54 | | 100.00 | | 11.69 | | | 22.08 |
| 7/28-8/11 | | 662.49 | | 18.91 | | 100.00 | | 22.83 | 8.77 | 3.28 | 5.86 |
| 8/11-8/25 | 8/18 | 288.52 | | 20.02 | | 100.00 | | 24.09 | | | 15.11 |
| 8/25-9/08 | | 167.12 | | 26.80 | | 100.00 | | 34.22 | | | 57.42 |
| 9/08-9/22 | 9/15 | 130.86 | | 11.81 | | 100.00 | | 20.33 | | | 14.35 |
| 9/22-10/6 | | 1316.27 | 25.83 | 8.97 | | 100.00 | | 12.41 | 4.07 | 2.04 | 1.65 |
| 10/6-10/20 | 10/13 | 15494.17 | 12.50 | 1.79 | 0.15 | 100.00 | 3.16 | 1.97 | 0.57 | 0.27 | 0.35 |
| 10/20-11/03 | | 3642.53 | 47.33 | 4.43 | 0.17 | 100.00 | 8.99 | 5.53 | 3.94 | 1.41 | 1.02 |
| 11/03-11/17 | 11/10 | 653.44 | | 2.79 | | 100.00 | 4.11 | 3.60 | 1.79 | | 2.73 |
| 11/17-12/01 | | 4071.95 | 32.81 | 6.31 | | 100.00 | 3.41 | 6.69 | 5.41 | 2.64 | 0.46 |
| 12/1-12/14 | 12/8 | 2814.35 | 27.79 | 16.54 | | 100.00 | 3.21 | 8.85 | 7.49 | 2.34 | |
| 12/14-1/5/89 | | 3897.07 | 7.94 | 15.73 | | 100.00 | 1.29 | 5.79 | 2.63 | 1.15 | 0.60 |

(a) All values are relative activities on resin sample, except for Cs-137, which is corrected for collection efficiency.

Table 5. Tritium Concentrations in 1988

(Values in pCi/mL)

| Date | Shell Bluff | Vogtle Vicinity[a] | | | Hwy 301 |
|---|---|---|---|---|---|
| | | + 0.3 mi | 0.0 mi | - 0.1 mi | |
| 1/12/88 | < 1.4 | < 1.2 | < 0.8 | < 1.8 | 4.2 ± 0.5 |
| 2/11/88 | < 1.0 | < 1.4 | < 1.1 | < 1.1 | 4.1 ± 0.8 |
| 3/10/88 | < 1.8 | 2.8 ± 0.8 | 1.9 ± 0.8 | 2.5 ± 0.8 | 3.1 ± 0.8 |
| 4/9/88 | < 1.5 | < 0.9 | < 1.7 | < 1.1 | 2.5 ± 0.7 |
| 5/19/88 | < 1.6 | 2.1 ± 1.0 | 1.6 ± 1.0 | < 2.0 | 3.9 ± 1.0 |
| 5/16/88 | < 1.4 | < 1.7 | < 1.4 | < 1.9 | 2.3 ± 0.8 |
| 7/14/88 | < 1.5 | < 1.9 | < 1.6 | < 1.1 | 2.3 ± 0.8 |
| 8/11/88 | < 1.4 | < 1.3 | < 1.3 | < 1.4 | 2.1 ± 0.8 |
| 10/6/88 | < 1.5 | < 1.3 | < 1.3 | < 1.4 | 1.2 ± 0.9 |
| 11/3/88 | < 1.4 | < 1.3 | < 1.3 | < 1.1 | 3.7 ± 0.8 |
| 12/14/88 | < 1.7 | < 1.7 | < 1.2 | < 1.7 | 4.0 ± 0.9 |

(a) Miles are measured upstream of Vogtle outfall.

Table 6. Sediment Concentrations in 1988

(Values in fCi/g)

| Isotope | Date | Shell Bluff[a] | Vogtle Vicinity[b] | | | Hwy 301 |
|---|---|---|---|---|---|---|
| | | | + 0.3 mi | 0.0 mi | - 0.1 mi | |
| Co-58 | 1/22/88 | - | < 4 | < 4 | 62 ± 3 | < 6 |
| | 3/14/88 | - | < 4 | < 6 | 76 ± 3 | < 6 |
| | 8/18/88 | - | < 6 | < 4 | 65 ± 2 | < 6 |
| Co-60 | 1/22/88 | - | < 1.7 | < 1.1 | 1.5 ± 0.7 | 2.6 ± 0.9 |
| | 3/14/88 | - | < 1.3 | ~1.2 | 4.5 ± 0.5 | 2.5 ± 0.3 |
| | 8/18/88 | - | 0.9 ± 0.3 | 1.7 ± 0.2 | 1.6 ± 0.4 | 2.5 ± 0.4 |
| Cs-137 | 1/22/88 | - | 7 ± 2 | < 4 | 11 ± 2 | 189 ± 4 |
| | 3/14/88 | - | 10 ± 2 | 7 ± 2 | 6 ± 2 | 145 ± 4 |
| | 8/18/88 | - | 17 ± 3 | 8 ± 2 | 7 ± 2 | 149 ± 4 |

(a) No data taken in 1988, as 1987 Shell Bluff concentrations were comparable to values 0.3 mi upstream of Vogtle. (Concentrations 0.3 mi upstream of Vogtle were essentially unchanged from 1987 to 1988).

(b) Miles are measured upstream of Vogtle outfall.

Table 7. Comparison of Maximum 1988 Levels with DOE Guides for Drinking Water

All measured levels from samples 0.1 mi downstream of Vogtle unless specified otherwise.

| | Isotopic Concentrations (pCi/L) | |
|---|---|---|
| Isotope | Maximum 1988 Level | DOE Guide[a] |
| H-3 | 4200[b] | 2,000,000 |
| Cr-51 | 2.8 | 1,000,000 |
| Mn-54 | 0.40 | 50,000 |
| Co-57 | 0.02 | 100,000 |
| Co-58 | 15.5 | 40,000 |
| Fe-59 | 0.49 | 20,000 |
| Co-60 | 0.49 | 5,000 |
| Nb-95 | 0.50 | 40,000 |
| Zr-95 | 0.23 | 60,000 |
| Cs-137 | 0.39[b] | 3,000 |

(a) DOE 5484.1 (details per reference 5).

(b) Level at Highway 301 Bridge.

FIGURE 1. Co-58 in Savannah River During 1988

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge

Negative values are MDAs.

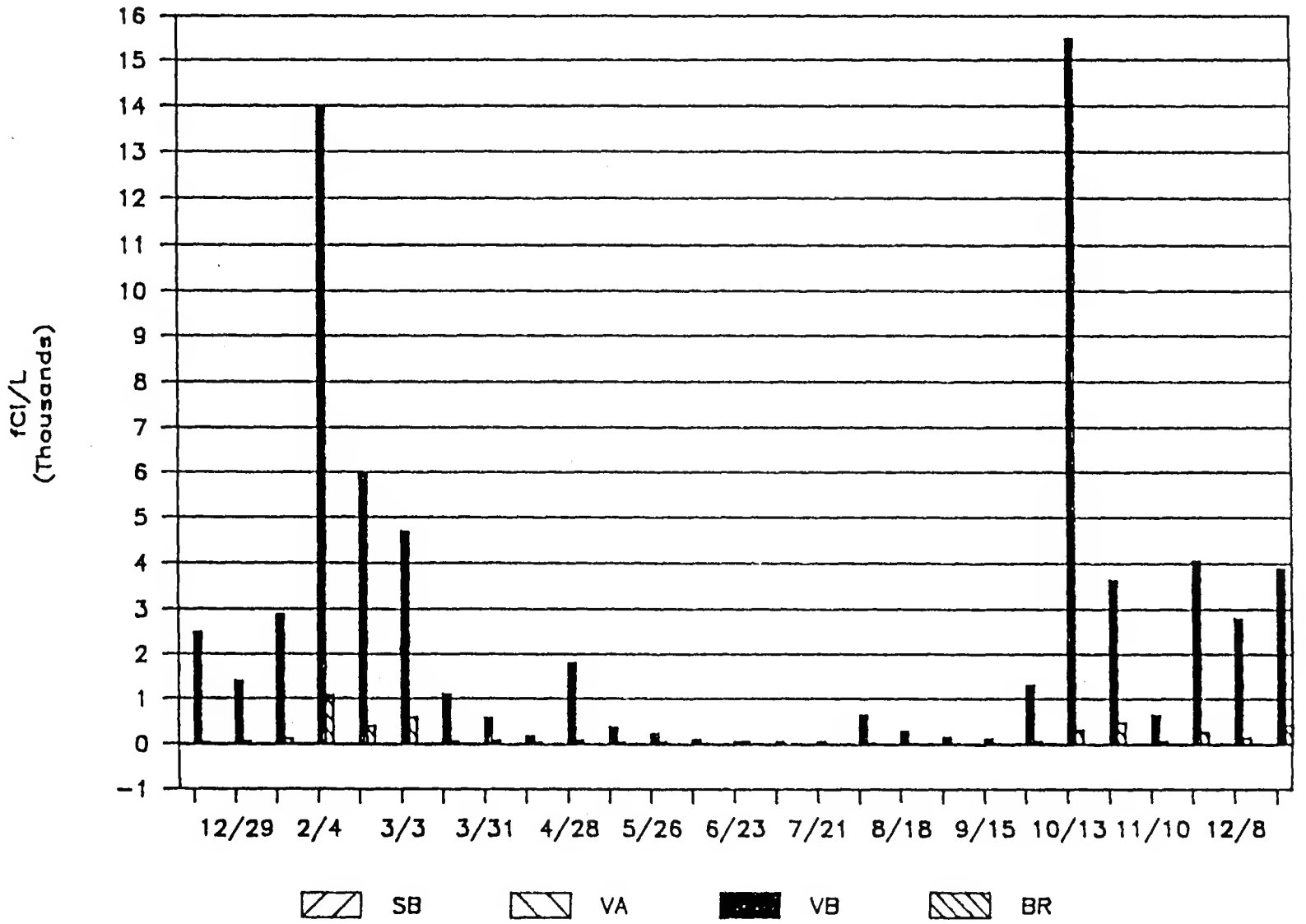


FIGURE 2. Co-60 in Savannah River During 1988

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge

Negative values are MDAs.

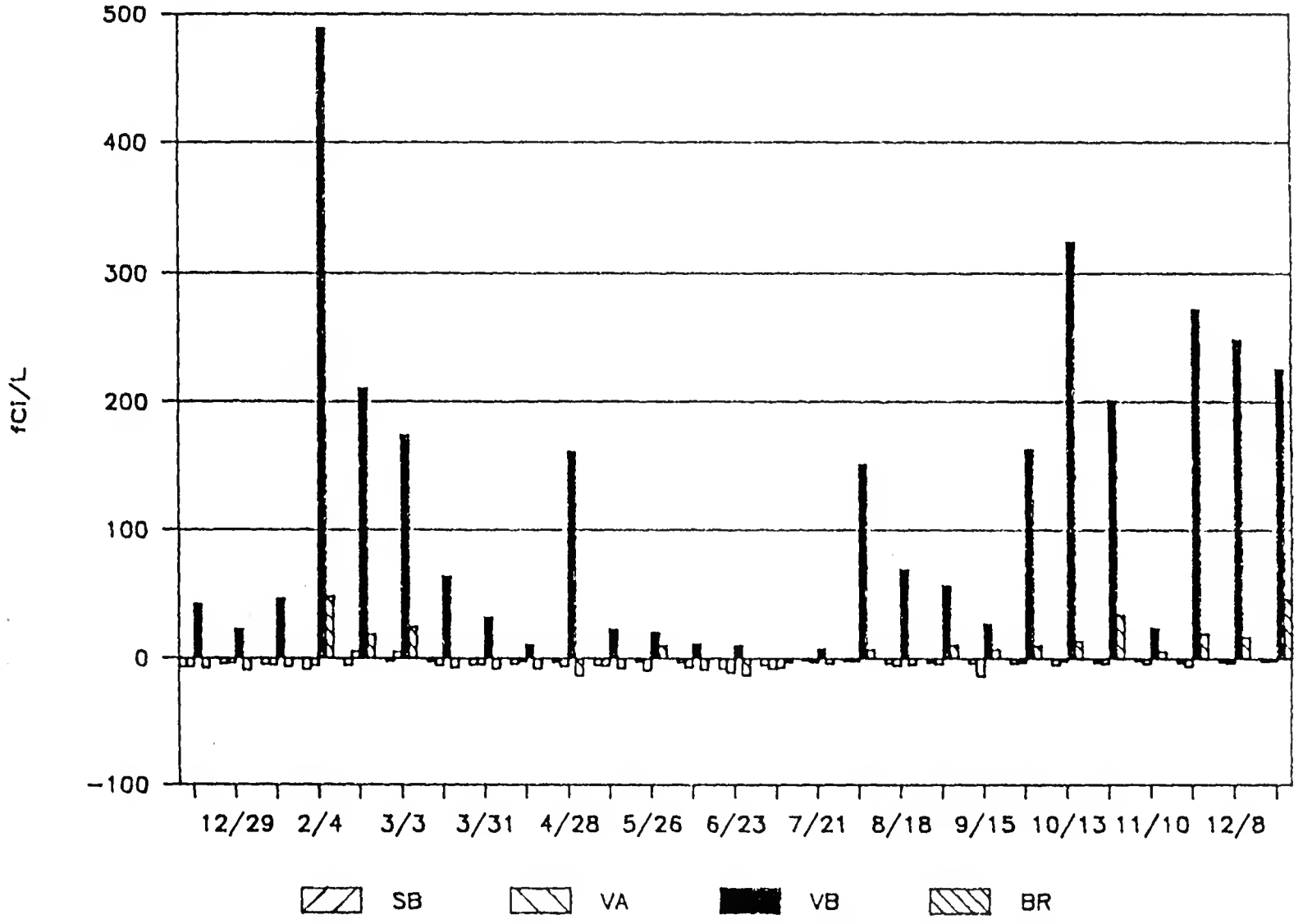
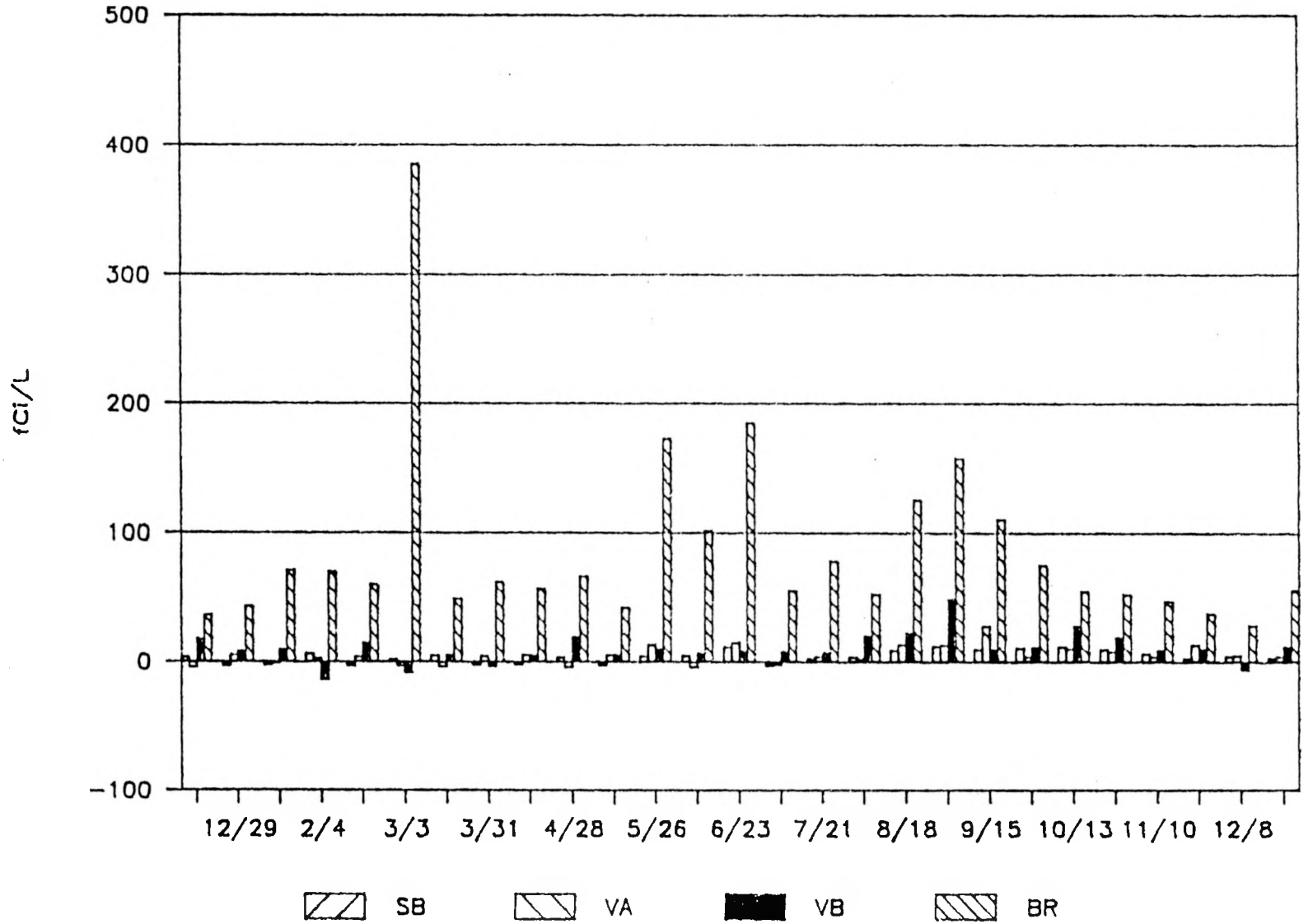


FIGURE 3. Cs-137 in Savannah River During 1988

Locations are defined as: SB = Shell Bluff
VA = 0.3 mi Upstream of Vogtle
VB = 0.1 mi Downstream of Vogtle
BR = Highway 301 Bridge

Negative values are MDAs.



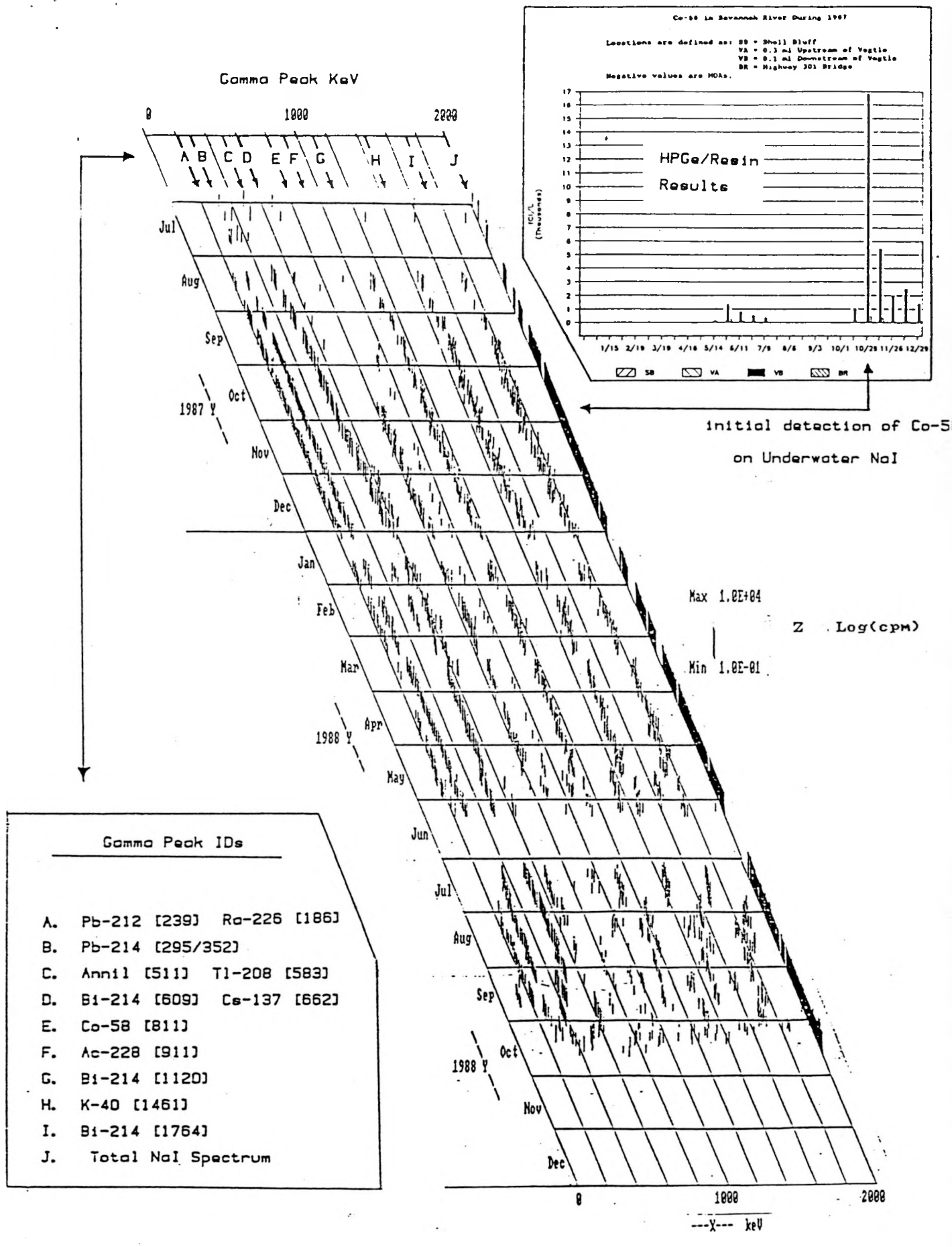



FIGURE 4. Results for Underwater NaI Detector at Hwy 301 Bridge

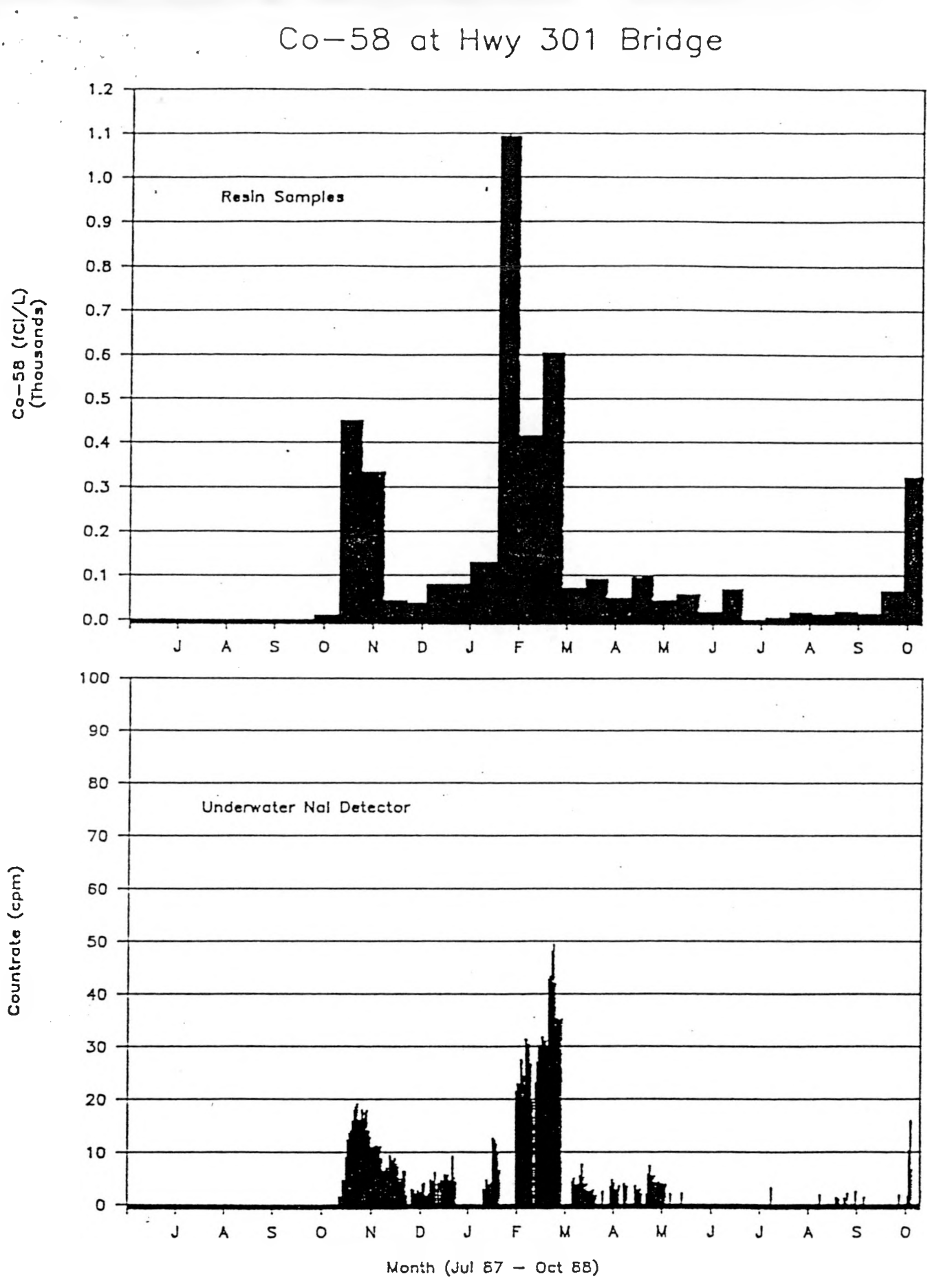



FIGURE 5. Comparison of Underwater NaI and Resin Sample Results