Long
Island
Power
Authority

Shoreham Nuclear Power Station
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APR 29 1992

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U. S. Nuclear Regulatory Commission
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Washington, D.C. 20555

Annual Radiological Environmental Monitoring Program
Shoreham Nuclear Power Station - Unit 1
Docket No. 50-322

Gentlemen:

Enclosed is a copy of the Shoreham Radiological Environmental Monitoring Program (REMP) Annual Report which provides detailed information for the full 1991 calendar year. Shoreham was in a defueled, non-operating condition during all of 1991. Shoreham's Technical Specification 6.8.1.3 requires this report to be submitted prior to May 1, 1992.

If you require additional information, please do not hesitate to contact me.

Very truly yours,

L. M. Hill
Resident Manager

MP/ab
Enclosure

cc: S. Brown
T. T. Martin
B. Norris

SHOREHAM NUCLEAR POWER STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 1 TO DECEMBER 31, 1991

ISSUED BY

NUCLEAR ENGINEERING DIVISION - LIPA

ENVIRONMENTAL ENGINEERING DEPARTMENT - LILCO

SHOREHAM NUCLEAR POWER STATION
RADIOLOGICAL ENVIRONMENTAL
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OPERATING REPORT

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report summarizes the Shoreham Nuclear Power Station's (SNPS) Radiological Environmental Monitoring Program (REMP) operations for 1991. Throughout 1991, the plant remained in a defueled condition with all fuel rods removed from the reactor core and plant activities in line with the anticipated license transfer to the Long Island Power Authority (LIPA).

Beginning in January 1991, strontium-89 and -90 analyses were discontinued after Safety Evaluations were conducted which allowed a reduction of REMP analyses to only those required by ODCM specifications. In June 1991, after additional Safety Evaluations pertaining to the defueled condition were completed and the Offsite Dose Calculation Manual (ODCM) was revised, the following reductions were made in the REMP surveillance program: milk, potable (ground) water sampling and iodine-131 analysis were discontinued. The outer thermoluminescent dosimeter (TLD) stations for direct radiation monitoring were also discontinued.

These reductions were made to recognize the fact that after the plant had been in the defueled mode for almost two years[1], iodine-131 had long since decayed away and is no longer present onsite as a potential release source isotope. Potable water sampling was discontinued because plant liquid effluents are discharged directly into the Long Island Sound, which is being monitored by REMP and is not a source of potable or irrigation water. The plant's non-operational status also eliminates the need for monitoring direct radiation at offsite TLD stations.

In July 1991, the Nuclear Regulatory Commission (NRC) granted LILCO a Possession Only Amendment to its previously obtained full power operating license for the Shoreham plant. This amended license, or the Possession Only License (POL), was implemented by LILCO in August 1991 and with it, all POL related changes in the Technical Specifications and the ODCM.

The objective of the SNPS REMP is to identify and measure plant related radioactivity in the environment and calculate the potential dose to the surrounding population. The operational phase, as well as the current non-operational, defueled phase, uses the preoperational baseline data to identify plant contributed radiation and evaluates the possible effects of radioactive plant effluents on the environment. The SNPS REMP is designed to comply with the plant's Technical Specifications, ODCM and NRC Regulatory Guides as described in licensing basis documents.

[1] Defueling at Shoreham was completed on August 9, 1989. All fuel was removed from the reactor vessel and stored in the Spent Fuel Storage Pool by that date.

The REMP data is acquired by sampling various media in the environment which are then analyzed for any radiation present. Media sampled within the aquatic environment in 1991 included surface water, fish, invertebrates (squid, lobsters, etc.) and sediment. The atmospheric environment was sampled for airborne particulates throughout the year; and airborne iodine, milk, and potable water, during the first half of the year. Starting June 1991, locally grown food products were sampled monthly during the growing season. Direct radiation was measured using TLDs.

Radioactivity in environmental media varies from sample to sample as well as geographically; therefore, a number of sampling locations for each medium were selected using available meteorological, land and water use data. Sampling locations are designated as either indicator or control locations. The indicator locations are placed close enough to Shoreham so that plant contributed radioactivity will be at its highest concentration. The control sample locations are placed so that they will be beyond measurable influence of Shoreham and any other nuclear facility. An exception to this occurred at the onshore site for REMP location 13G2, at the entrance to Port Jefferson Harbor. During preoperational testing aquatic samples revealed the presence of low levels of iodine-131. An investigation revealed that the iodine-131 was from area hospitals treating patients for thyroid carcinoma. Thereafter, until 1990 a second onshore aquatic background location was sampled at the entrance to Mt. Sinai Harbor.

A number of radioactivity analyses were performed on each medium sampled. Not all samples underwent all types of radioanalyses; only those analyses appropriate for the particular medium sampled were performed. The analyses included gamma spectrometry, iodine-131, tritium, gross beta radiation and direct radiation. Iodine-131 analyses was discontinued after June 1991 under the revised ODCM requirements which reflect the plant's defueled, non-operating status.

Dose calculations for the SNPS environs were performed using concentrations of radioactivity detected in the samples collected. In all cases the calculated doses were similar to the background doses calculated for the previous years. Therefore, no environmental radioactivity was identified as having originated from SNPS.

I. PROGRAM

THE PROGRAM

The Shoreham Nuclear Power Station's (SNPS) Radiological Environmental Monitoring Program (REMP) is conducted in compliance with NRC Regulatory Guide 4.15, licensing commitments, the Defueled Safety Analysis Report (DSAR) 11.6, SNPS Technical Specification Section 6.7.4.b, and SNPS Offsite Dose Calculation Manual (ODCM) Section 3/4.12. The REMP was developed in general accordance with the NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, Nov. 1979, and findings in the Environmental Report (ER) 6...5. All samples were collected by personnel of the Long Island Lighting Company (Environmental Engineering Department) or biological contractors hired for the collection of aquatic samples. A synopsis of the sampling program can be found in Table 1. Maps and a description of sampling locations appear in Appendix B.

During 1991 sample analyses were performed by Teledyne Isotopes of Westwood, New Jersey (referred to throughout the text as either "TI" or "the laboratory"), under contract to LILCO. A summary of analytical results appears in Appendix A and individual analysis results in Appendix C. Aquatic sample collections were performed by LILCO's Environmental Engineering Department and Energy & Environmental Analysts Inc. (EEA Inc.) under contract to LILCO.

A. Objectives

The objectives of the radiological environmental monitoring program are:

1. Identify and measure radiation and radioactivity in the plant environs for the calculation of potential dose to the population.

2. Verify the effectiveness of in-plant measures used for controlling the release of radioactive materials.

3. Provide reasonable assurance that the predicted doses, based on effluent data, have not been substantially underestimated and are consistent with applicable standards.

4. Comply with regulatory requirements, SNPS Technical Specifications and ODCM requirements, and provide records to document compliance.

B. Sample Collection

1. Aquatic Environment

The aquatic environment at the SNPS site was examined by analyzing samples of surface water, fish, invertebrates, and sediment. Surface water samples were taken at three locations in May and October using a Niskin bottle. The samples were placed in new polyethylene bottles following three rinses with the sample medium prior to collection. Samples of Bluefish (Pomatomus saltatrix), Winter Flounder (Pseudopleuronectes americanus), Windowpane (Scophthalmus aquosus), Sea Robin (Prionotus spp), Little Skate (Raja erinacea) and Fluke (Paralichthys dentatus) were taken by trawl, sealed in plastic bags, frozen, and shipped to the laboratory for analysis.

Invertebrate samples of American Lobster (Homarus americanus), Squid (Loligo pealeii) and Channeled Whelk (Busycon canaliculata) were collected by trawl. Channeled Whelk were also collected using pots. These invertebrate samples were sealed in plastic bags, frozen and shipped to the laboratory for analysis.

Beach sediment samples were also collected, sealed in plastic bags, frozen and shipped to the laboratory.

2. Atmospheric Environment

The atmospheric environment was examined by analyzing airborne particulates collected on Gelman Type A/E filters using low volume air samplers (approximately 1 cfm). Airborne iodine was collected by absorption on triethylenediamine (TEDA) impregnated charcoal cartridges, manufactured by Scott, which were connected in series behind the airborne particulate filters. The samplers used were equipped with a vacuum recorder for sample volume correction to ensure sample validity and to indicate any maintenance problems. Should the sampler lose vacuum due to a leak the vacuum level reading will drop to zero. Since this may occur without a corresponding loss of electric supply the exact time of the maintenance problem will be evident on the vacuum recorder chart.

Collection and analyses of airborne samples for idoine-131 were discontinued after June 25, 1991 under ODCM Rev. 17 to reflect the plant's defueled condition. The last iodine air sample was collected for the week of June 18 - 25, 1991.

Sample volumes were measured using dry gas meters and corrected for differences between the actual pressure seen by the

volume meter and the average atmospheric pressure. Sample volumes are corrected to standard pressure using average weekly barometric pressure (measured at LILCO's Environmental Engineering Department, Melville) and air sampler vacuum readings. Time totalizers indicate the duration of time the sample was taken.

3. Terrestrial Environment

The terrestrial environment was examined by analyzing samples of milk and potable water during the first half of 1991, and of food products during the growing season (June to November) for the second half of the year.

When available, milk samples were collected from three locations monthly except during the pasture season in May and June, when the sampling was increased to twice a month. Milk samples were shipped on ice with sodium bisulfite ($NaHSO_3$) preservative added.

Potable water was collected during the first and the second quarters from three well locations. However, samples were unavailable from a fourth well, 13S2, presumably due to a change in the water table.

Milk and potable water samplings were discontinued for the second half of 1991, when Revision 17 of the ODCM became effective. This revision of ODCM reflects the plant's defueled, non-operating conditions. Milk samples were last collected on June 13 and potable water, June 6, 1991.

4. Direct Radiation

Direct radiation levels in the environs were measured with energy compensated calcium sulfate ($CaSO_4$:Dy) TLDs, each containing four separate readout areas. The TLDs are annealed by LILCO prior to placement in the field. After the quarterly collection, the TLDs are packaged and shipped to the laboratory for analysis along with a control dosimeter, and new ones are placed for the next quarterly period.

ODCM Revision 17 also reduced the TLD stations from 41 to 18. This reduction took place after the second quarter TLDs were collected on July 11, 1991. The 41 locations for the first two quarters included 4 that were added in 1989 at various area schools to better determine direct radiation levels at these sites. The present 18 locations include 16 onsite stations with one in each of the 16 meteorological sectors, plus two control locations at 11G1 and 12G1.

C. Quality Assurance

1. Teledyne Isotopes

Teledyne Isotopes has an extensive quality assurance program designed to ensure the precision and accuracy of the data generated. An Interlaboratory Comparison Program is conducted with the Environmental Protection Agency (EPA). The results of the Program analyses are listed in Appendix E. Participation in this program permits estimation of bias in TI results from the deviation from the "known" value given, or by comparison with means of all participants. The TI Quality Assurance Program for Radiological Monitoring is described in various TI publications (References 15, 16, 17).

Approximately 10 percent of TI's total analytical effort is spent on quality control including process quality control, instrument quality control, intra and interlaboratory cross-check, and comprehensive data review. In addition, LILCO specifically requires that two percent of its analyses be duplicated for further quality control cross check.

Additional information on the LILCO Quality Assurance Program is provided in NED 4170004, Quality Assurance Program for Radiological Environmental Monitoring Program, Shoreham Nuclear Power Station.

D. Data Interpretation

1. General

The analytical data generated during 1991 were routinely evaluated by the TI project leader who served as liaison with Long Island Lighting Company's Environmental and Nuclear Engineering Departments. Several factors are important in the interpretation of the data. These factors are discussed here to avoid repetition in sections that follow.

Within the data tables (Appendix C) an approximate 95 percent (±2 sigma) confidence interval is supplied for those data points above the lower limit of detection (LLD). These intervals represent the range of values into which 95 percent of repeated analyses of the same sample would fall. Tables C-13 and C-14 present typical and required LLDs, respectively.

Results for each type of sample were grouped according to the analysis performed. Means and standard deviations of these results are calculated when applicable. The calculated standard deviations of grouped data represent sample rather than analytical variability. For

these calculations any values below LLD are considered to be at the LLD As a result, the means are biased high and the standard deviations are biased low. When a group of data is composed of LLD values, averages are not calculated.

Grab sampling is a useful and acceptable procedure for taking environmental samples of a medium in which the concentration of radionuclides is expected to vary minimally with time or where intermittent sampling is deemed sufficient to establish the radiological characteristics of the medium. This method, however, is only representative of the sampled medium for that specific location and instant of time. As a result, variation of radionuclide concentrations in the samples will normally occur. Since these variations will tend to counterbalance one another, the extraction of averages based upon repetitive grab samples is valid.

2. Gamma Isotopic Analyses

SNPS ODCM Table 3.12.1-1 requires that analyses be performed on all media for gamma emitting radionuclides which may be attributable to effluents from the plant. These analyses are in addition to requirements for specific gamma emitters such as I-131, Cs-134, Cs-137, Ba-140, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Zr-95 and Nb-95. Industry experience suggests that these are the most likely radionuclides to find their way into the environment from a BWR nuclear power plant. Gamma spectroscopy is expected to identify most other nuclides which may be discharged when the LLDs for specified gamma emitters are met by this technique.

Tables 3.1 and 3.2 of the Shoreham Final Environmental Statement list the calculated liquid and gaseous effluents by radionuclide in curies per year. These release rates assume normal operation of the plant, including anticipated operational occurrences. Those nuclides listed in Tables 3.1 and 3.2 which are not routinely observable by gamma spectroscopy and which are not specifically analyzed in other ways fall into two categories:

1. Those radionuclides with half-lives on the order of hours or minutes which cannot accumulate appreciably in the environment (Na-24, Cu-64, Zn-69m, Zn-69, Sr-91, Y-91m, Y-92, Y-93, Tc-99m, Rh-103m, Rh-105, Rh-106, Te-129, Te-131m, Te-131, I-132, I-135, Ba-137m, Pr-143, Ce-143, Pr-144 and W-187).

2. Those radionuclides with no gammas (P-32, Fe-55), those with a trivial percentage of their transitions going by gamma emissions (Y-91), or those with their primary gamma

occurring at such a low energy and at such low abundance that it is not routinely observable in the presence of other gamma activity (Nd-147). With only 10 pCi of Nd-147 calculated to be released per year in Shoreham's liquid effluents, the nuclide cannot be an important contributor to dose.

E. Dose Assessment

The methodology for determining doses is similar for all pathways. Laboratory analyses from the REMP for each sample type are compiled. Data from all locations taken on the same date are averaged to obtain the most reliable approximation of the radioactivity concentration on that date for that sample type. The averages of all dates are then taken to provide the best approximation of radioactivity concentrations for the year.

When an average value has been obtained which represents a sample medium or an exposure pathway, it can then be used to calculate the dose for the year. Additional information, such as the quantity of fish, milk, vegetables, etc., consumed per year by the maximum exposed individual is also needed to calculate the total dose (Reference 13).

The dose due to direct radiation exposure is monitored by TLDs. The laboratory results for TLDs are expressed in dose units directly and do not require any additional calculations.

The dose to the total body or to a specific organ is then calculated by the product of the radionuclide specific dose conversion factor for its applicable exposure pathway, the environmental sample radionuclide concentration, and the ingestion or inhalation rate of the sample or medium of interest. For example, the following general equation expresses this principle:

Dose (mRem/yr)	=	Concentration per sample	X Quantity ingested per year	X Dose factor

The sample concentration is typically expressed in pCi/l or pCi/kg. For the ingestion pathway, the quantity ingested or consumed per year is expressed in kg/year or l/year. Finally, the dose conversion factor is expressed in terms of mRem/pCi ingested or inhaled.

F. Program Summary

Table 1 summarizes information on the REMP as performed during the period of this report, January 1 through December 31, 1991. During this reporting period 704 separate analyses were performed on 638 environmental samples.

Appendix A summarizes the analytical results obtained from the SNPS REMP. The format used is that recommended in NRC Radiological Assessment Branch Technical Position (BTP), Rev. 1, Nov. 1979. Appendix B describes the sample coding system, which specifies sample type and relative locations at a glance. In addition, pertinent information on individual sampling locations, and maps which show their geographic location, are included.

Appendix C presents the analytical results of the Shoreham Nuclear Power Station's Radiological Environmental Monitoring Program for the period January 1 through December 31, 1991. Appendix D contains a synopsis of the analytical procedures used in the REMP.

Results of the EPA interlaboratory comparison program can be found in Appendix E. Appendix F lists the program exceptions for 1991, and Appendix G reports the Land Use Census performed by LILCO's Environmental Engineering Department during 1991 in the vicinity of the SNPS. Common and scientific names of species collected in the program are presented in Appendix H.

TABLE 1

SYNOPSIS OF THE SHOREHAM NUCLEAR POWER STATION'S RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM FOR THE PERIOD JANUARY 1 THROUGH DECEMBER 31, 1991

SAMPLE TYPE	SAMPLING FREQUENCY	LOCATIONS	NUMBER COLLECTED	ANALYSIS	ANALYSIS FREQUENCY	NUMBER PERFORMED
Aquatic Environment						
Surface Water	Semiannual	3	6	I-131	Semiannual	3
				H-3	Semiannual	6
				Gamma	Semiannual	6
Fish	Semiannual	3	33	Gamma	Semiannual	33
Invertebrates	Semiannual	3	19	Gamma	Semiannual	19
Sediment - Beach	Semiannual	1	2	Gamma	Semiannual	2
Atmospheric Environment						
Airborne Particulates	Weekly	5	264	Gross Beta	Weekly	264
				Gamma	Quarterly	20
Airborne Iodine	Weekly	5	125	I-131	Weekly	125

TABLE 1 (Cont.)

SYNOPSIS OF THE SHOREHAM NUCLEAR POWER STATION'S RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM FOR THE PERIOD JANUARY 1 THROUGH DECEMBER 31, 1991

SAMPLE TYPE	SAMPLING FREQUENCY	LOCATIONS	NUMBER COLLECTED	ANALYSIS	ANALYSIS FREQUENCY	NUMBER PERFORMED
Terrestrial Environment						
Milk	Biweekly (1)	3	24	I-131	Biweekly (1)	24
				Gamma	Biweekly (1)	24
Potable Water	Quarterly (2)	3	5	Gamma	Quarterly	5
				I-131	Quarterly	5
				H-3	Quarterly	5
Food Products	Monthly (3)	5	42	Gamma	Monthly	42
				I-131	Monthly	3
Direct Radiation						
TLDs	Quarterly	41/18 (4)	118	Gamma Dose	Quarterly	118

(1) Milk was collected biweekly during the pasture season and monthly during the nongrazing season until 6/13/91, and was discontinued thereafter per ODCM Rev. 17.
(2) Potable water samples were last collected on 6/6/91, and discontinued thereafter per ODCM Rev. 17.
(3) Food product samples were collected monthly during harvest season, starting 6/12/91, to comply with SNPS Offsite Dose Calculation Manual Rev. 17, Table 3.12.1.
(4) TLD locations were reduced from 41 to 18 stations for the 3rd and 4th quarters.

II. RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The analytical results for the reporting period of January 1 through December 31, 1991, have been divided into four categories: aquatic, atmospheric, terrestrial, and direct radiation. The individual samples and analyses within each category display the unique radiological characteristics of that type of environment. Strontium-89 and -90 analyses were discontinued on January 1, 1991, reducing the REMP to ODCM requirements. In June 1991 due to a program change, several additional sampling and analyses were discontinued. Analytical results of the REMP are summarized in Appendix A. The data for individual analyses are presented in Appendix C.

A. Aquatic Environment

The aquatic environment in the vicinity of SNPS consists primarily of Long Island Sound. The radiological characteristics were studied by analyzing samples of surface water, Winter Flounder, Windowpane, Sea Robin, Bluefish, Little Skate, Fluke, American Lobster, Squid, Channeled Whelk, and sediment. The samples were collected by LILCO's Environmental Engineering Department and Energy & Environmental Analysts Inc. (EEA Inc.) under contract to LILCO.

1. Surface Water (Table C-1)

Semiannual surface water samples were taken at three locations and were analyzed for tritium, gamma emitters, and iodine-131.

There was no detectable tritium in any surface water sample. This compares consistently with the 1990 tritium results, which were also all below the detection limit.

Naturally occurring potassium-40 was measured in all six semiannual samples over three locations with an average of 188 pCi/l and a range between 143 and 235 pCi/l, as compared with 1990's average of 289 pCi/l and a range between 232 and 354 pCi/l. No other gamma activity above the detectable levels was measured in the six surface water samples as analyzed by gamma spectroscopy.

The May surface water samples were also analyzed for iodine-131. Iodine-131 was not observed within the limits of detection.

2. Fish (Table C-2)

Thirty-three fish samples were collected at three locations and the edible portions analyzed for gamma emitters. Gamma spectrometry showed potassium-40 present in all samples with an average concentration of 3451

pCi/kg wet and a range between 1540 to 4940 pCi/kg wet, comparing with 1990's average of 4242 pCi/kg wet and a range between 1990 and 10900 pCi/kg wet. Cesium-137 was not detected in any samples. This favors well with the detection of cesium-137 in three fish samples during 1990.

3. Invertebrates (Table C-3)

Nineteen invertebrate samples, comprised of lobsters, squid, and whelk, were collected at three locations and analyzed for gamma emitters. Gamma spectrometry showed detectable levels of potassium-40 in all samples, ranging from 1380 to 7980 pCi/kg wet with an average activity of 3176 pCi/kg wet. Thorium-228 was measured in one lobster sample with an activity of 117 pCi/kg wet. These compare to 1990's average potassium-40 activity of 3171 pCi/kg wet and an average of cesium-137 activity of 33.8 pCi/kg wet out of two samples of lobsters.

4. Sediment (Table C-4)

Two beach sediment samples were collected and analyzed for gamma emitters. Both samples had measurable activities of naturally occurring potassium-40 with an average activity of 2350 pCi/kg dry and a range of 2090 to 2610 pCi/kg dry. Thorium-228 was measured in both samples with an average activity of 164 pCi/kg dry and a range of 141 to 186 pCi/kg dry. All other gamma emitters were below the lower limits of detection.

B. Atmospheric Environment

The atmospheric environment in the vicinity of the SNPS was examined by analyzing samples of airborne particulates and airborne iodine at five sampling locations. TEDA-impregnated charcoal cartridges used to collect airborne iodine were collected weekly until June 25, 1991 when this analysis was discontinued. They were analyzed by gamma spectrometry for iodine-131. Airborne particulate filters were collected weekly and analyzed for beta emitters. Quarterly composites from each station were analyzed for gamma emitters.

1. Airborne Particulates (Tables C-5, C-6, and C-7)

Beta-emitter concentrations ranged from 0.004 to 0.035 pCi/m^3 with an annual average for the five sampling locations of 0.016 pCi/m^3 (Table C-5). Of the 264 measurements five were below the detection limit, nominally 0.003 pCi/m^3. Figure 1 shows the average weekly gross beta fluctuations in airborne particulates from all stations for 1991. Figure 2 represents the average monthly gross beta results in airborne particulates from January 1, 1977 through December 31, 1991.

Results of gamma spectrometry (Table C-6) showed detectable levels of naturally occurring beryllium-7 in all twenty samples. The average beryllium-7 activity in the quarterly analyses was 0.073 pCi/m^3 with a range of 0.041 to 0.117 pCi/m^3. Naturally occurring potassium-40 was not observed. All other gamma emitters were below the lower limit of detection.

2. Airborne Iodine (Table C-7)

Analytical results of the 125 weekly airborne iodine-131 samples were all below the lower limit of detection, with a range of results between <0.008 and <0.06 pCi/m^3.

C. Terrestrial Environment

The terrestrial environment in the vicinity of the SNPS was examined by analyzing samples of milk and potable water during the first half of the year, and food products during the remainder of the year. Gamma spectrometry was performed on all samples. In addition, iodine-131 analyses were performed on the milk samples, while tritium and iodine-131 analyses were performed on the potable water samples.

1. Milk (Tables C-8 and C-9)

All of the 24 monthly and semimonthly cow and goat milk samples analyzed for iodine-131 were below the LLD with sample results ranged between <0.1 and <0.3 pCi/l. Naturally occurring potassium-40 was observed in all the milk samples. The goat milk samples had an average measurement of 1578 pCi/l and a range of 1280 to 1900 pCi/l. The cow milk samples had an average concentration of 926 pCi/l with a range of 775 to 1140 pCi/l. Cesium-137 was detected in one of the 14 goat milk samples with an activity of 6.88 pCi/l. Nine of the 10 cow milk samples at Control Location 8G2 had detectable measurements of cesium-137 with an average of 10.5 pCi/l and a range of 6.31 to 14.2 pCi/l. All other gamma emitters were below the lower limits of detection.

2. Potable Water (Table C-10)

Five potable water samples were collected at three locations during 1991. All tritium results were below the lower limit of detection (100 pCi/l). No iodine-131 was measured above the lower limit of detection which were all <0.1 pCi/l. All other gamma emitters were below the lower limits of detection.

3. Food Products (Table C-11)

Forty-two fruit and vegetable food products grown locally were collected and analyzed, including tomatoes, potatoes, cabbage, lettuce, carrots, peaches, strawberries, and corn. All samples contained naturally occurring potassium-40 with an average of 2786 pCi/kg wet and a range of 1190 to 4880 pCi/kg wet. Also naturally occurring beryllium-7 was observed in one sample of lettuce with a concentration of 131 pCi/kg wet. All other gamma emitters were below the lower limits of detection. The samples were also analyzed for iodine-131 by a radiochemical procedure. No activity was found. The detection limit varied from 3 to 100 pCi/kg wet.

D. Direct Radiation (Table C-12)

Direct radiation measurements were taken quarterly at 41 locations during the first two quarters of 1991 and 18 locations during the last two quarters of 1991, using $CaSO_4$:Dy thermoluminescent dosimeters (TLDs). TLDs were used to detect radiation levels near ground level in the vicinity of the Shoreham site due to terrestrial and cosmic gamma ray emitters and possible SNPS contributed direct radiation. Figure 3 presents a comparison of average TLD results from 1977 to 1991.

All TLD results presented in this report have been normalized to a standard month (30.4 days) to eliminate the apparent differences caused by the variations in exposure period. The average of the quarterly exposures of all 41 locations was 3.5 mR/standard month. This is less than quarterly values, respectively, measured during the preoperational years 1983 and 1984.

Annual average results of all quarters at the same locations, as well as of all locations for each quarter, are given in Table C-12 with 95% confidence limits for the mean value, except for the average of all locations and all quarters. For this last value, the 95% limits about any individual measurement, i.e., ±0.9 mR/std. month, is given. The 95% limits for the mean of all locations and all quarters (N=118) are ±0.08 mR/std. month about the sample mean of 3.6 mR/std. month for 1991.

E. Dose Assessment

Initially, all positive concentrations of radionuclides in indicator samples, as shown in Appendix A, were considered for inclusion in the dose calculation. In an attempt to factor out as much of the contribution due to natural and man-made background radiation as possible, indicator and control sample results were compared. If the control location results were

greater than those at the indicator location, the indicator sample results were not included in the dose assessment.

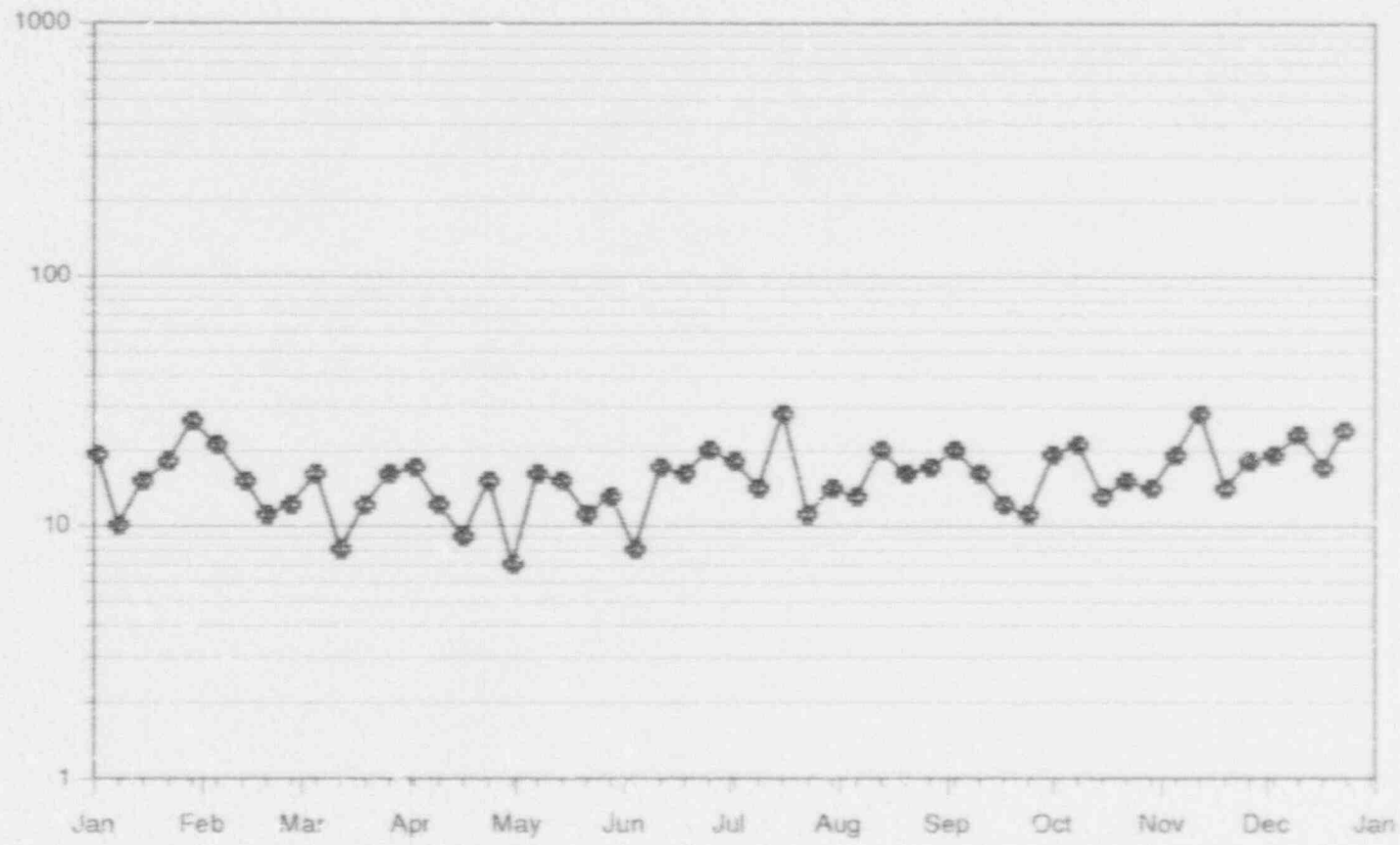
Surface water from Long Island Sound was not considered as a significant human exposure pathway and therefore, not considered in the dose assessment. The dose due to standing on soil/sediment was not calculated since this is accounted for in the direct radiation dose. Also, potable water was excluded from dose calculations because it is not considered a pathway. (Since ground water drainage is to the north into the Sound, no water sources for drinking or irrigation can be affected.) In 1991, no radionuclide in the analysis category was detected above the lower limits of detection in any of the potable water samples.

Beryllium-7, potassium-40, radium-226, radium-228 and thorium-228 are all naturally occurring isotopes and not likely to be produced as a result of the operation of Shoreham, so they were excluded. The remaining positive isotope, cesium-137, was found in the milk samples. However, since the sample average at the control location (8G2), 10.5 pCi/l, is higher than that at the indicator locations (13B1 and 8F2) which is 6.88 pCi/l, it is also excused. The milk produced in the vicinity of Shoreham that was monitored under REMP has not been a source of commercial supply and is of limited quantity. It should be noted that cesium-137 exists in the Shoreham environment as a result of atmospheric weapons testing and the Chernobyl accident.

Comparison of environmental concentrations found in 1991 shows that they are consistent with those of 1983. For 1991, therefore, there is no discernible dose components other than those from natural sources in the environment.

FIGURE 1

AVERAGE WEEKLY GROSS BETA RESULTS IN AIRBORNE PARTICULATES



1991

FIGURE 2

COMPARISON OF AVERAGE MONTHLY GROSS BETA RESULTS IN AIRBORNE PARTICULATES

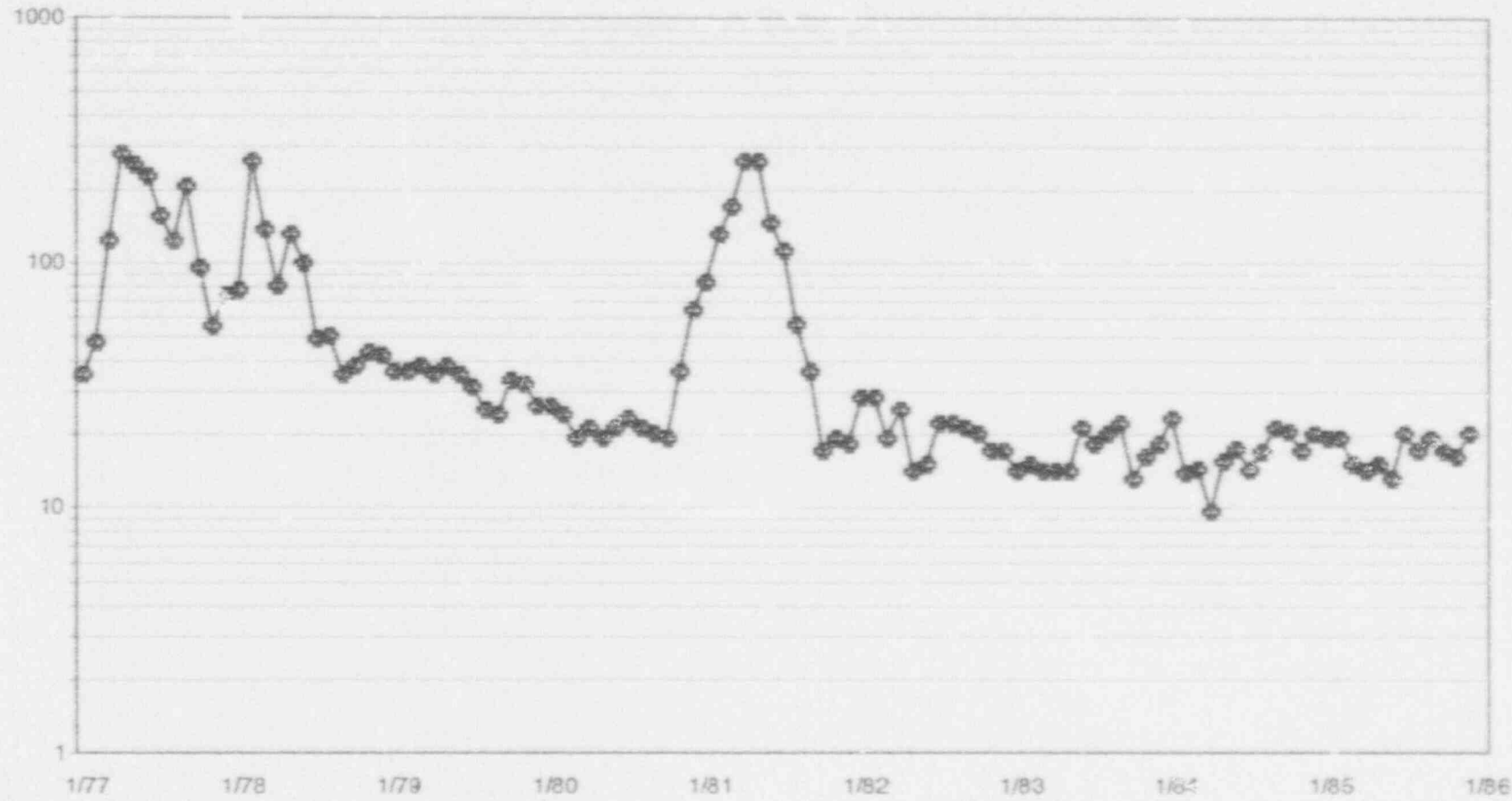


FIGURE 2 (Cont.)

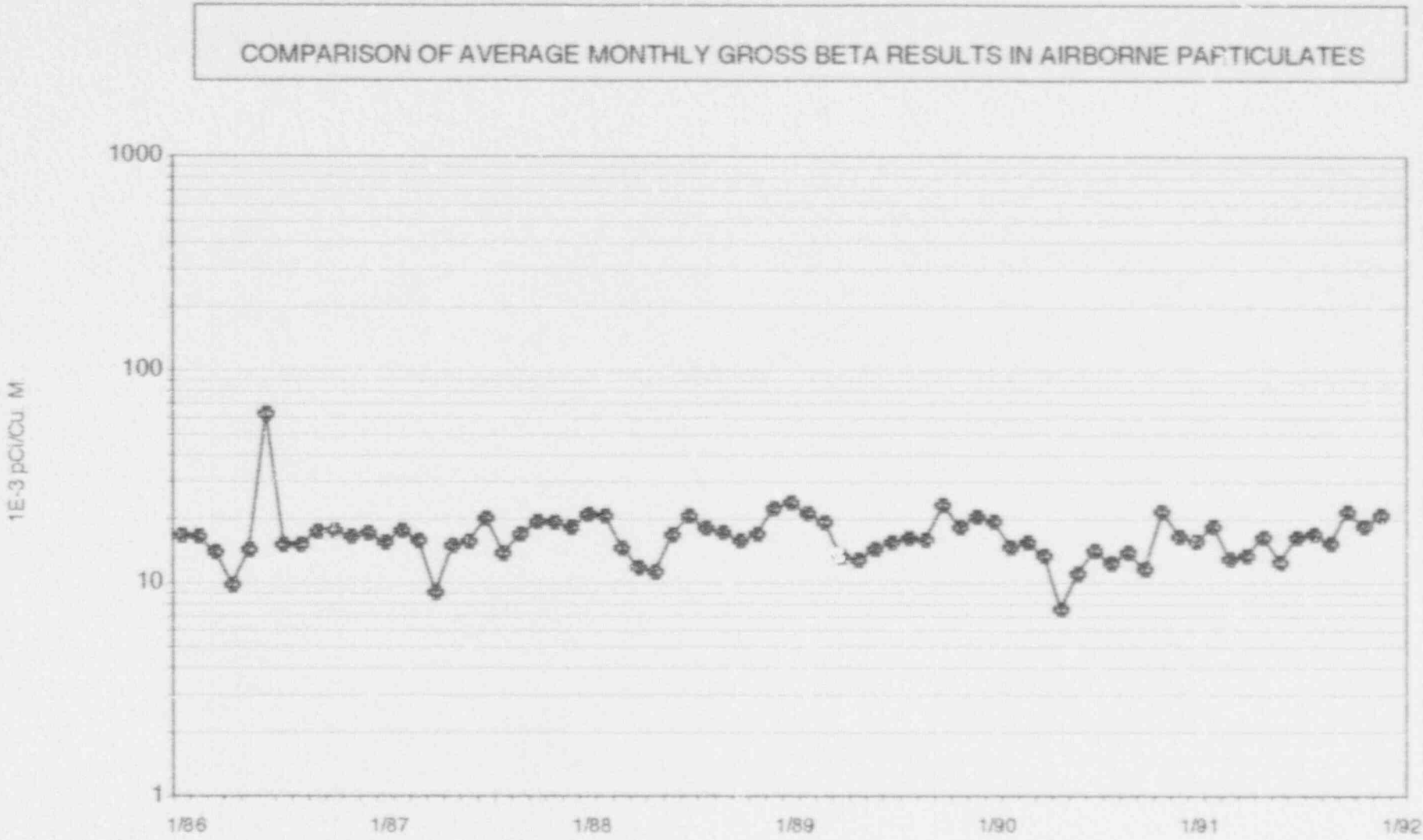
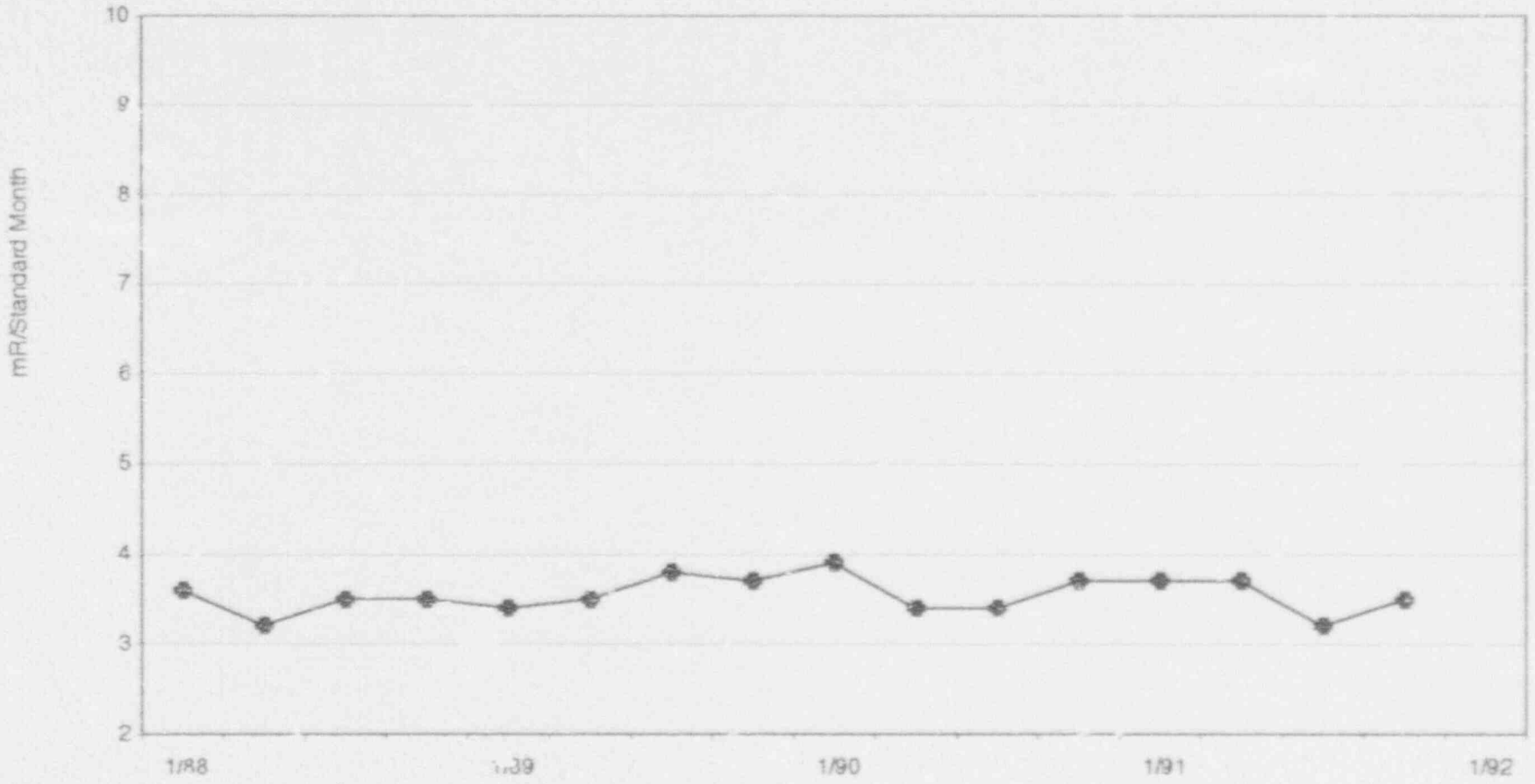


FIGURE 3

COMPARISON OF AVERAGE TLD RESULTS (1977-1988)

FIGURE 3 (Cont.)

COMPARISON OF AVERAGE TLD RESULTS (1988-1992)



III. CONCLUSIONS

CONCLUSIONS

The unit was defueled in August 1989, and has subsequently been in a non-operating condition.

Analyses of environmental samples show results consistent with those found during the preoperational years of 1983 and 1984. In addition, comparison of results reveals little difference between indicator and control locations. Therefore, no isotopes could be identified as having originated from SNPS.

Sensitive indicators revealed minute quantities of radioactive fallout from the October 1980 atmospheric nuclear weapons test by the Peoples Republic of China and the Chernobyl accident in addition to radioactivity remaining from two decades of atmospheric testing.

Aside from these anomalies in the environment, expected normal background radioactivity has been measured in REMP samples. Aquatic and terrestrial samples were analyzed and reflected the normal background radiation found in the environment. The atmospheric environment was sampled for airborne particulates and Figure 1 shows weekly gross beta results in airborne particulates from January through December 1991. Figure 2 shows the average monthly gross beta results in airborne particulates from February 1977 to December 1991. Direct radiation levels were relatively low and approximately the same at all locations. Figure 3 shows the average quarterly TLD results in mR/standard month from January 1977 to December 1991.

IV. REFERENCES

IV. REFERENCES

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(2) United States Atomic Energy Commission, Directorate of Licensing, "Final Environmental Statement Related to Operation of Shoreham Nuclear Power Station", Docket No. 50-322, September 1972.

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(16) Teledyne Isotopes, "Quality Control Internal Controls and Audits, Environmental Analysis Department", IWL-0032-365.

(17) Teledyne Isotopes, "Quality Assurance Manual, Environmental Analysis Department Compliance with 10CFR50 Appendix B and Reg. Guide 4.15", IWL-0032-395.

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(21) Long Island Lighting Co. and Teledyne Isotopes, 1985 Radiological Environmental Monitoring Program Annual Report.

(22) Long Island Lighting Co. and Teledyne Isotopes, 1986 Radiological Environmental Monitoring Program Annual Report.

(23) Long Island Lighting Co. and Teledyne Isotopes, 1987 Radiological Environmental Monitoring Program Annual Report.

(24) Long Island Lighting Co. and Teledyne Isotopes, 1988 Radiological Environmental Monitoring Program Annual Report.

(25) Long Island Lighting Co. and Teledyne Isotopes, 1989 Radiological Environmental Monitoring Program Annual Report.

(26) Long Island Lighting Co. and Teledyne Isotopes, 1990 Radiological Environmental Monitoring Program Annual Report.

(27) Defueled Safety Analysis Report (DSAR), Rev. 3, July 1991.

APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY 1991

TABLE A-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION — DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK — JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Surface Water (pCi/liter)	H-3	6	100	-(0/4)	N/A	N/A	-(0/2)	0
	I-131	3	0.4	-(0/2)	N/A	N/A	-(0/1)	0
	Gamma	6						
	K-40		60	190(4/4) (161-235)	14C1 2.1 mi WNW	202(2/2) (168-235)	183(2/2) (143-223)	0
	Cs-137		4	-(0/4)	N/A	N/A	-(0/2)	0
Fish (pCi/kg wet)	Gamma	33						
	K-40		300	3391(23/23) (1540-4830)	13G2 13.2 mi W	3588(10/10) (1890-4940)	3588(10/10) (1890-4940)	0
	Th-228		7	-(0/23)	N/A	N/A	-(0/10)	0
	Cs-137		5	-(0/23)	N/A	N/A	-(0/13)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-[illegible] (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK JANUARY 1 to DECF*1BER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Aquatic Invertebrates (pCi/kg wet)	Gamma 19						
	Be-7	200	-(0/14)	N/A	N/A	-(0/5)	0
	K-40	300	3416(14/14) (2240-7980)	14C1 2.1 mi WNW	3710(7/7) (2240-7980)	2504(5/5) (1380-3320)	0 0
	Cs-137	4	-(0/14)	N/A	N/A	-(0/5)	0
	Th-228	7	117(1/14)	14C1 2.1 mi WNW	117(1/7)	-(0/5)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Sediment (Beach) (pCi/kg dry)	Gamma 2						
	K-40	900	2350(2/2) (2090-2610)	2A4 0.4 mi NNE	2350(2/2) (2090-2610)	(0/0) -	0
	Cs-137	8	(0/2) -	N/A	N/A	(0/0) -	0
	Ra-226	200	(0/2) -	N/A	N/A	(0/0) -	0
	Th-228	60	164(2/2) (141-186)	2A4 0.4 mi NNE	164(2/2) (141-186)	(0/0) -	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Airborne Particulates (10^{-3}pCi/m^3)	Gross Beta 264	4	16.6(206/211) (4.3-35)	2A2 0.2 mi NNE	17.4(52/52) (7.1-31)	16.3(53/53) (8.3-28)	0
	Gamma 20						
	Be-7	-	71.4(16/16) (40.9-115)	11G1 16.6 mi SW	77.2(4/4) (49.3-117)	77.2(4/4) (49.3-117)	0
	K-40	5	-(0/16)	N/A	N/A	-(0/4)	0
	Cs-134	0.4	-(0/16)	N/A	N/A	-(0/4)	0
	Cs-137	0.4	-(0/16)	N/A	N/A	-(0/4)	0
Airborne Iodine (10^{-3}pCi/m^3)	I-131 125	8	-(0/100)	N/A	N/A	-(0/25)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.
(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.
(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION — DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK — JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Milk (pCi/liter)	I-131	24 0.2	-(0/14)	N/A	N/A	-(0/10)	0
	Gamma	24					
	K-40	100	1581(14/14) (1280-1900)	13B1 1.9 mi W	1660(8/8) (1280-1900)	926(10/10) (775-1140)	0
	Cs-137	4	6.88(1/14)	8G2 10.8 mi SSE	10.5(9/10) (6.31-14.2)	10.5(9/10) (6.31-14.2)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED		LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Potable Water (pCi/liter)	H-3	5	100	-(0/4)	N/A	N/A	-(0/1)	0
	I-131	5	0.2	-(0/4)	N/A	N/A	-(0/1)	0
	Gamma	5						
	K-40		50	-(0/4)	N/A	N/A	-(0/1)	0
	Cs-137		0.6	-(0/4)	N/A	N/A	-(0/1)	0
	Th-228		1	-(0/4)	N/A	N/A	-(0/1)	0
Direct Radiation (mR/Standard month)	Gamma Dose Quarterly	118	1.5	3.57(102/102) (2.7-5.5)	6A 0.7 mi ESE	5.05(2/2) (4.6-5.5)	3.67(16/16) (3.1-4.8)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

TABLE A-1 (Cont.)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

SHOREHAM NUCLEAR POWER STATION DOCKET NO. 50-322

SUFFOLK COUNTY, NEW YORK JANUARY 1 to DECEMBER 31, 1991

MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	ANALYSIS AND TOTAL NUMBER OF ANALYSES PERFORMED	LOWER LIMIT OF DETECTION (LLD) (1)	ALL INDICATOR LOCATIONS(3) MEAN (2) RANGE	LOCATION WITH HIGHEST MEAN NAME DISTANCE AND DIRECTION	MEAN(2) RANGE	CONTROL LOCATION(3) MEAN(2) RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
Food Products (pCi/kg wet)	Gamma 42						
	K-40	300	2837(29/29) (1190-4880)	8B1 1.2 mi SSE	3065(21/21) (1680-4880)	2675(13/13) (1890-3880)	0
	Be-7	50	131(1/29)	8B1 1.2 mi SSE	131(1/21)	-(0/13)	0
	Cs-137	6	-(0/29)	N/A	N/A	-(0/13)	0
	I-131 (4) 3	3	-(0/2)	N/A	N/A	-(0/1)	0

(1) The LLDs quoted are the lowest actual LLDs obtained in the various media during the reporting period. Typical LLDs were determined for each nuclide as found on Tables C-13 and C-14.

(2) Means calculated using detectable measurements only. Fractions of detectable measurements in parentheses.

(3) Indicator and control locations are noted in Appendix B, Table B-1.

(4) These are radiochemistry lab analyses. I-131 by gamma analyses are not included as separate analyses here. See Table C-11 for more details.

APPENDIX B

SAMPLE DESIGNATION AND SAMPLING LOCATIONS

APPENDIX B

Sample Designation

LILCO's Radiological Environmental Monitoring Program (REMP) identifies samples by a three part code. The first two letters are the power station identification code, in this case "SN". The next three letters are for the media sampled.

SWA	= Surface Water (Long Island Sound)	MLK	= Milk
AQF	= Fish (1)	GMK	= Goat Milk
AQI	= Invertebrates (1)	PWA	= Potable Water (ground water)
AQS	= Sediment	FPV	= Food Products (1)
APT	= Airborne Particulates	FPF	= Fruit
AIO	= Airborne Iodine	IDM	= Immersion Dose (TLD)

The last four symbols are a location code based on direction and distance from the site. Of these, the first two represent each of the sixteen angular sectors of 22 1/2 degrees centered about the reactor site. Sector one is divided evenly by the north axis, and other sectors are numbered in a clockwise direction, i.e., 2=NNE, 3=NE, 4=ENE, etc. The next digit is a letter which represents the radial distance from the plant:

S	= On site location	E	= 4-5 miles off site
A	= 0-1 miles off site	F	= 5-10 miles off site
B	= 1-2 miles off site	G	= 10-20 miles off site
C	= 2-3 miles off site	H	= >20 miles off site
D	= 3-4 miles off site		

The last number is the location numerical designation within each sector and zone, e.g., 1,2,3,.....for example, the designation SN-SWA-3C1 would indicate a sample in the SNPS program SN, consisting of surface water SWA, which had been collected in the 22-1/2 degree sector centered on the northeast axis (3) between the site boundary and 2-3 miles off site (C). The number 1 indicates that this is sampling station No. 1 in the designated area.

Sampling Locations

All sampling locations and specific information about the individual locations are given in Table B-1. Tables B-2 through B-5 list the sampling locations and media required by Technical Specifications.

(1) A more specific means of classification will be noted in the comment section of each laboratory report for these samples. For example, AQI will be designated, in the sample description, as aquatic invertebrate. However, the comment section will specify the sample type by the generally accepted common name of the sample involved. In this case, clam, lobster, crab or other aquatic invertebrate would be listed in the comment section.

Maps B-1, B-2 and B-3 show the locations of 1991 sampling stations with respect to the site. These maps are tracings of portions of larger maps prepared by LILCO's Survey Division after an extensive land survey of REMP monitoring locations. Additional information can be obtained by referring to the Site and Vicinity Map of the Shoreham Nuclear Power Station (Map B-2), the map of Long Island and Connecticut Shore (Map B-3) and by contacting either LILCO's Environmental Engineering Department or Survey Division. Tables B-1 through B-4 include the locations and sample types which were discontinued in the second half of 1991. In Table B-5, they are marked and footnoted as such.

TABLE B-1

Sampling Locations Required By SNPS Offsite Dose Calculation Manual

SECTOR		LOCATION CODE	LOCATION	SAMPLE TYPE
N		1S1	Beach east of intake, 0.3 mi. N	IDM(*)
NNE		2S1	Well, on site, 0.1 mi. NNE	PWA(*)
NE		3S1	Site Boundary, 0.1 mi. NE	APT(*),AIO(*),IDM(*)
ENE		4S1	Site Boundary, 0.1 mi. ENE	IDM(*)
E		5S2	Site Boundary, 0.1 mi. E	IDM(*)
ESE		6S2	Site Boundary, 0.1 mi. ESE	APT(*),AIO(*),IDM(*)
S		9S1	Service Road, 0.2 mi. S	IDM(*)
S		9S2	East Gate SNPS, 0.3 mi. S	IDM(*)
W		13S2	Well, on site, 0.2 mi. W	PWA(*)
W		13S3	Site Boundary, 0.2 mi. W	IDM(*)
WNW		14S2	St. Joseph's Villa, 0.4 mi. WNW	IDM(*)
NW		15S1	Beach west of intake, 0.3 mi. NW	IDM(*)
NNW		16S2	Site Boundary, 0.3 mi. NNW	IDM(*)
NNE		2A2	West end of Creek Road, 0.2 mi. NNE	APT(*),AIO(*),IDM(*)
NNE		2A3	Residence, 0.3 mi. NNE	IDM(*),PWA
NNE		2A4	Beach, 0.4 mi. NNE	AQS(*)
ESE		6A1	Sound Road, 0.7 mi. ESE	IDM(*)
SE		7A2	North Country Road, 0.7 mi. SE	IDM(*)
SSE		8A2	North Country Road, 0.6 mi. SSE	IDM(*)
SSW		10A1	North Country Road, 0.3 mi. SSW	IDM(*)
SW		11A1	Site Boundary, 0.3 mi. SW	IDM(*)
WSW		12A1	Meteorological Tower, 0.9 mi. WSW	IDM(*)
ENE		4B1	Little Flower Institute, Wading River, 1.5 mi. ENE	IDM
ESE	C	6B1	Remsen Road, Wading River, 1.6 mi. ESE	PWA
SE		7B1	Overhill Road, Wading River, 1.4 mi. SE	APT(*), AIO(*),IDM(*)
SE		7B4	Wading River Elementary School, Wading River, 1.6 mi. SE	IDM
SSE		8B1	Farm stand 1.2 mi. SSE	FPV(*),FPF
ESE		6B21	Farm stand 1.8 mi ESE	FPV(*),FPF

TABLE B-1 (Cont.)

SECTOR		LOCATION CODE	LOCATION	SAMPLE TYPE
S		9B2	Shoreham-Wading River High School, Shoreham, 1.2 mi. S	IDM
WSW		12B2	Miller Avenue School, Shoreham, 1.6 mi. WSW	IDM
W		13B1	Briarcliff Road, 1.9 mi. W	GMK
NE		3C1	Outfall area, aquatic location B-5, 2.9 mi. NE	AQF(*),AQI(*), SWA(*)
E		5C2	Farm, 2.8 mi. E	FPV,FPF
WNW		14C1	Outfall area, aquatic location B-4, 2.1 mi. WNW	SWA(*),AQF(*), AQI(*)
E		5D1	Wildwood State Park, 3.4 mi. E	IDM(*)
E		5D3	Wildwood State Park, 3.1 mi. E	IDM
WSW		12D1	North Shore Beach Substation 3.7 mi. WSW	IDM(*)
E		5E2	Calverton, 4.5 mi. E	IDM(*)
ESE		6E1	LILCO ROW, 4.8 mi. ESE	IDM(*)
SE		7E1	Calverton, 4.9 mi. SE	IDM(*)
SSE		8E1	Calverton, 4.4 mi. SSE	IDM(*)
S		9E1	Brookhaven National Laboratory 5.0 mi. S	IDM(*)
SSW		10E1	Ridge Substation, 4.0 mi. SSW	IDM(*)
SW		11E1	LILCO ROW, 4.7 mi. SW	IDM(*)
W		13E1	Longview Ave. and Rocky Point Landing Rd., 4.5 mi. W	IDM(*)
E	C	5F3	Farm, 7.8 mi. E	IDM(*)
SSE		8F2	Goat Farm, Wading River Rd., 9.5 mi. SSE	GMK
SSW	C	10F1	Goat Farm, 9.2 mi. SSW	GMK(*)
ESE	C	6G1	Francis Court, Hampton Bays, 19.0 mi. ESE	IDM(*
SSE	C	8G1	Wading River Rd., 10.1 mi. SSE	IDM(*)
SSE	C	8G2	Dairy Farm, Center Moriches, 10.8 mi. SSE	MLK
SW	C	11G1	MacArthur Substation, 16.6 mi. SW	APT(*),AIO(*), IDM(*)
WSW	C	12G1	Central Islip Substation, 19.9 mi. WSW	IDM(*)
WSW	C	12G2	Flowerfield Substation, 15.4 mi. WSW	IDM(*)
W	C	13G2	Background aquatic location, 13.2 mi. W	SWA(*) AQF(*),AQI(*)
WSW	C	12H1	Farm, 25.8 mi. WSW	FPV(*),FPF(*)
WSW	C	12H2	Farm, 32.1 mi. WSW	FPV, FPF

C Denotes Control Location
* Denotes SNPS ODCM sampling locations and sample type.
** Bottled Milk

REMP LOCATIONS REQUIRED BY
SNPS OFFSITE DOSE CALCULATION MANUAL

TABLE B-2

Airborne Particulate and Airborne Iodine Monitoring Stations

Location Codes		
NUREG-0473	SHOREHAM REMP	Location Description
A1	6S2	Site Boundary, 0.1 mi. ESE
A2	2A2	West end of Creek Road, 0.2 mi. NNE
A3	3S1	Site Boundary, 0.1 mi., NE
A4	7B1	Overhill Road, 1.4 mi. SE
A5	11G1	MacArthur Substation, 16.6 mi. SW

TABLE B-3

Waterborne Monitoring Stations

Location Codes		
NUREG-0473	SHOREHAM REMP	Location Description
WA1	13G2	Surface, background area, 13.2 mi. W
WA2	14C1	Surface, outfall area, 2.1 mi. WNW
WA3	3C1	Surface, outfall area, 2.9 mi. NE
Wb1	2S1	Potable Water, well on site, 0.1 mi. NNE
Wb2	13S2	Potable Water, well on site, 0.2 mi. W
Wd1	2A4	Sediment, Beach, 0.4 mi. NNE

TABLE B-4

Ingestion Monitoring Stations

Location Codes		
NUREG-0473	SHOREHAM REMP	Location Description
Ia1	13B1	Goat Farm, 1.9 mi. W
Ia2	10F1	Goat Farm, 9.2 mi. SSW
	8C2	Dairy (Cow), 10.8 mi SSE
Ib1	3C1	Fish and Invertebrates, outfall area, 2.9 mi. NE
Ib2	14C1	Fish and Invertebrates, outfall area, 2.1 mi. WNW
Ib3	13G2	Fish and Invertebrates, background, 13.2 mi. W
Ic1	8B1	Local Farm, 1.2 mi. SSE
Ic2	6B21	Local Farm, 1.8 mi. ESE
Ic3	12H1	Background Farm, 25.8 mi. WSW

REMP LOCATIONS REQUIRED BY
SNPS OFFSITE DOSE CALCULATION MANUAL

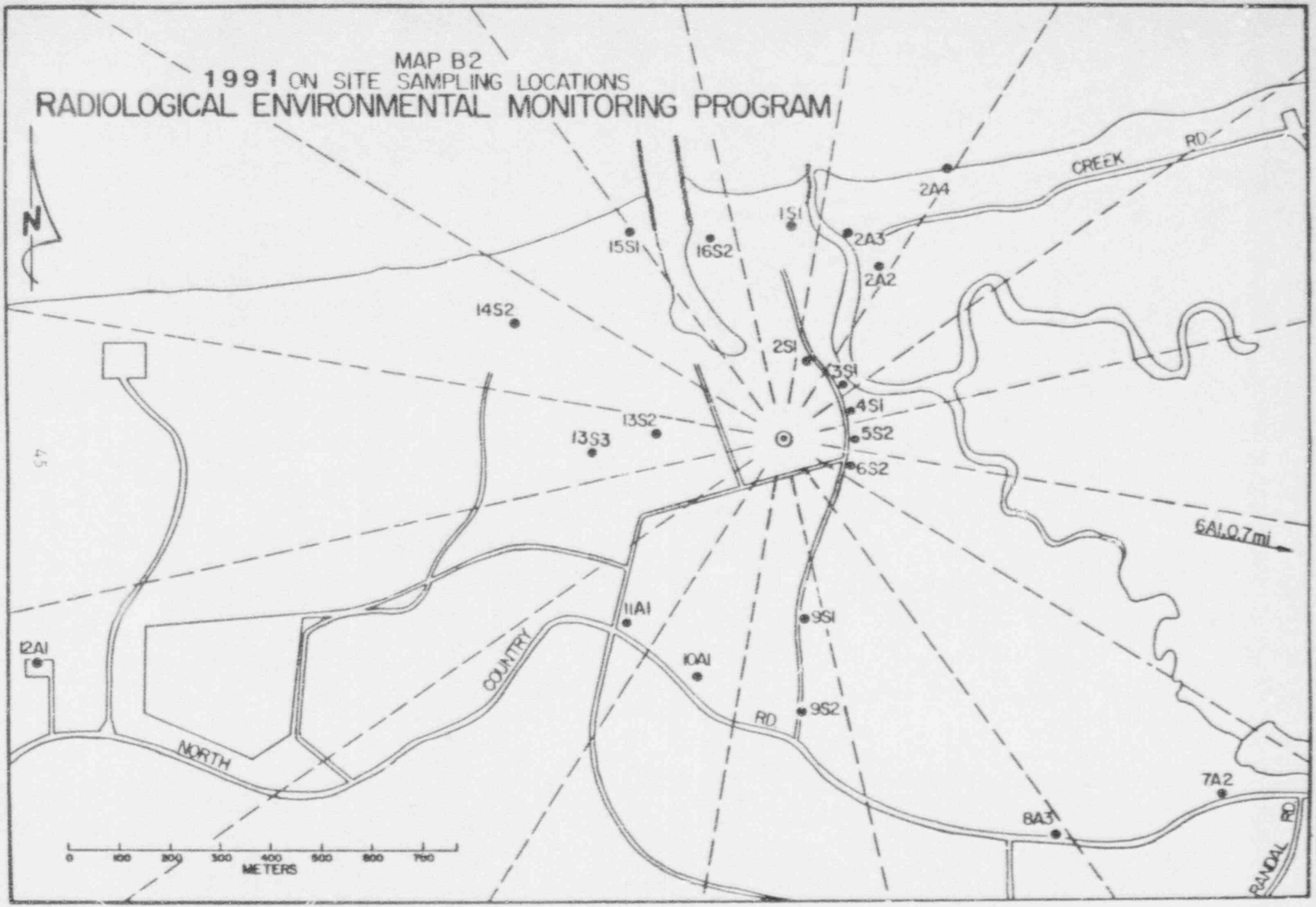
TABLE B-5

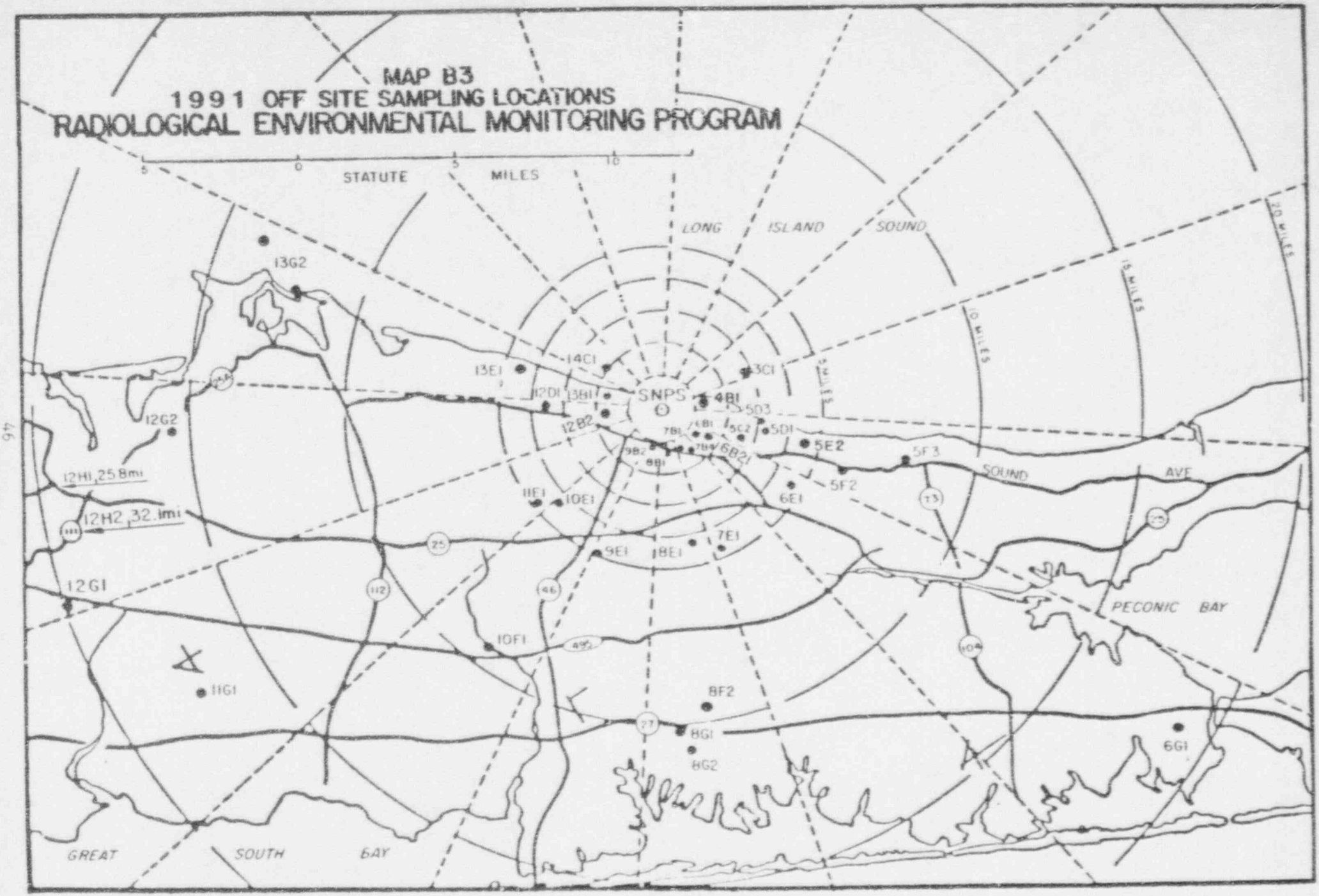
Direct Radiation Monitoring Stations

Location Codes NUREG-0473	SHOREHAM REMP	Location Description
DR1	1S1	Beach east of intake, 0.3 mi. N
DR2	2A2	West end of Creek Road, 0.2 mi. NNE
DR3	3S1	Site Boundary, 0.1 mi. NE
DR4	4S1	Site Boundary, 0.1 mi. ENE
DR5	5S2	Site Boundary, 0.1 mi. E
DR6	6S2	Site Boundary, 0.1 mi. ESE
DR7	7A2	North Country Road, 0.7 mi. SE
DR8	8A3	North Country Road, 0.6 mi. SSE
DR9	9S1	Service Road SNPS, 0.2 mi. S
DR10	10A1	North Country Road, 0.3 mi. SSW
DR11	11A1	Site Boundary, 0.3 mi. SW
DR12	12A1	Meteorological Tower, 0.9 mi. WSW
DR13	13S3	Site Boundary, 0.2 mi. W
DR14	14S2	St. Joseph's Villa, 0.4 mi. WNW
DR15	15S1	Beach west of intake, 0.3 mi. NW
DR16	16S2	Site Boundary, 0.3 mi. NNW
*DR17	5E2	Calverton, 4.5 mi. E
*DR18	6E1	LILCO ROW, 4.8 mi. ESE
*DR19	7E1	Calverton, 4.9 mi. SE
*DR20	8E1	Calverton, 4.4 mi. SSE
*DR21	9E1	Brookhaven National Laboratory, 5.0 mi. S
*DR22	10E1	Ridge Substation, 4.0 mi. SSW
*DR23	11E1	LILCO ROW, 4.7 mi. SW
*DR24	12D1	North Shore Beach Substation, 3.7 mi. WSW
*DR25	13E1	Longview Ave. and Rocky Point Landing Rd. 4.5 mi. W
*DR26	5D1	Wildwood State Park, 3.4 mi. E
*DR27	5F3	Dairy Farm, 7.8 mi. E
*DR28	7B1	Overhill Road, 1.4 mi. SE
*DR29	12G2	Flowerfield Substation, 15.4 mi. WSW
DR30	12G1	Central Islip Substation, 19.9 mi. WSW
DR31	11G1	MacArthur Substation, 16.6 mi. SW
*DR32	8G1	Wading River Road, 10.1 mi. SSE
*DR33	6G1	Hampton Bays Substation, 19.0 mi. ESE
*DR34	6A1	Sound Road, 0.7 mi. ESE
*DR35	2A3	Nearest Residence, 0.3 mi. NNE
*DR36	9S2	East Gate SNPS, 0.3 mi. S

* These locations were discontinued after 7/11/91. See Section I.B.4 for details.

MAP B-1
SHOREHAM SITE LOCATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM


MAP B2
1991 ON SITE SAMPLING LOCATIONS
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
N
15S1
16S2
1S1
2A4
2A3
2A2
14S2
2S1
3S1
4S1
5S2
6S2
13S2
13S3
6A1 0.7mi
11A1
9S1
12A1
10A1
9S2
COUNTRY
RD
NORTH
7A2
8A3
RANDAL RD
CREEK RD
0 100 200 300 400 500 600 700
METERS


MAP B3
1991 OFF SITE SAMPLING LOCATIONS
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
5 0 5 10
STATUTE MILES
LONG ISLAND SOUND
5 MILES
10 MILES
15 MILES
20 MILES
SNPS
13G2
14C1
13E1
12D1
13B1
3C1
4B1
503
12B2
12G2
12H1, 25.8mi
12H2, 32.1mi
12G1
11E1
10E1
9E1
8E1
7E1
6E1
5E2
5F3
5F2
SOUND AVE
PECONIC BAY
10F1
11G1
8F2
8G1
8G2
6G1
GREAT SOUTH BAY
46

APPENDIX C

DATA TABLES

TABLE C-1

CONCENTRATIONS OF TRITIUM AND GAMMA EMITTERS* IN SURFACE WATER SAMPLES

Results in Units of pCi/l ± 2 sigma

LOCATION CODE	COLLECTION DATE	H-3 (a)	I-131	K-40	Cs-137
SN-SWA-3C1	05/13/91	< 100	< 0.4**	196 ± 33	< 4
	10/08/91	< 200		161 ± 56	< 5
SN-SWA-13G2 (c1)	05/13/91	< 100	< 0.5**	223 ± 48	< 6
	10/08/91	< 200		143 ± 31	< 4
SN-SWA-14C1	05/13/91	< 100	< 0.4**	168 ± 35	< 4
	10/08/91	< 200		235 ± 34	< 4
Average ± 2 s.d.				**188 ± 73**	

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.

** I-131 results determined by radiochemical analysis. Iodine-131 analysis by radiochemistry was discontinued after this collection due to a REMP program change.

(a) Tritium analysis performed semiannually.

(c1) Denotes Control Location.

TABLE C-2

CONCENTRATIONS OF GAMMA EMITTERS* IN FISH SAMPLES

Results in Units of pCi/kg (wet) ± 2 sigma

LOCATION CODE	COLLECTION DATE	DESCRIPTION	K-40	Cs-137	Th-228
SN-AQF-3C1	05/06/90	Winter Flounder	3730 ± 520	< 30	< 60
	05/06/91	Windowpane	3930 ± 500	< 20	< 40
	05/06/91	Winter Flounder	4320 ± 520	< 30	< 60
	05/06/91	Little Skate	2270 ± 350	< 20	< 40
	05/06/91	Sea Robin	4250 ± 440	< 30	< 30
	10/01/91	Windowpane	3580 ± 610	< 70	< 100
	10/01/91	Winter Flounder	3900 ± 470	< 30	< 50
	10/01/91	Bluefish	3640 ± 410	< 40	< 50
	10/01/91	Fluke	4830 ± 480	< 30	< 50
	10/01/91	Sea Robin	3820 ± 520	< 40	< 60
	10/01/91	Skate	2120 ± 350	< 30	< 50
	10/01/91	Skate	2440 ± 430	< 40	< 50
SN-AQF-14C1	05/07/91	Sea Robin	4340 ± 430	< 30	< 50
	05/07/91	Winter Flounder	3860 ± 510	< 30	< 60
	05/07/91	Little Skate	2490 ± 440	< 40	< 60
	05/07/91	Little Skate	2870 ± 410	< 30	< 50
	05/07/91	Windowpane	3300 ± 550	< 40	< 80
	10/02/91	Sea Robin	4330 ± 700	< 40	< 60
	10/02/91	Skate	2170 ± 330	< 30	< 40
	10/02/91	Windowpane	1540 ± 450	< 50	< 60
	10/02/91	Winter Flounder	3770 ± 410	< 20	< 40
	10/02/91	Skate	2110 ± 470	< 30	< 60
	10/02/91	Fluke	4390 ± 430	< 40	< 50
SN-AQF-13G2 (c)	05/08/91	Winter Flounder	4090 ± 410	< 20	< 40
	05/08/91	Windowpane	3280 ± 440	< 30	< 50
	05/08/91	Sea Robin	3590 ± 460	< 30	< 70
	05/08/91	Little Skate	2350 ± 470	< 30	< 50
	10/04/91	Fluke	4260 ± 510	< 30	< 50
	10/04/91	Winter Flounder	4940 ± 540	< 30	< 50
	10/04/91	Windowpane	3240 ± 560	< 30	< 50
	10/04/91	Sea Robin	4310 ± 530	< 20	< 40
	10/04/91	Skate	1890 ± 450	< 30	< 50
	10/04/91	Bluefish	3930 ± 450	< 30	< 50
Average ± 2 s.d.			**3451 ± 1846**		

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.

(c) Denotes Control Location.

TABLE C-3

CONCENTRATIONS OF GAMMA EMITTERS* IN INVERTEBRATE SAMPLES

Results in Units of pCi/kg (wet) ± 2 sigma

LOCATION CODE	COLLECTION DATE	DESCRIPTION	Be-7	K-40	Cs-137	Th-228
SN-AQI-3C1	05/06/91	Lobster	< 200	2840 ± 320	< 20	< 40
SN-AQI-3C1	05/06/91	Lobster	< 400	4070 ± 480	< 40	< 60
SN-AQI-3C1	05/13/91	Whelk	< 300	2250 ± 420	< 20	< 50
SN-AQI-3C1	10/01/91	Lobster	< 200	3910 ± 430	< 20	< 40
SN-AQI-3C1	10/01/91	Squid	< 300	2660 ± 430	< 40	< 50
SN-AQI-3C1	10/01/91	Lobster	< 300	2930 ± 390	< 30	< 50
SN-AQI-3C1	10/08/91	Whelk	< 300	3190 ± 450	< 30	< 50
SN-AQI-14C1	05/07/91	Lobster	< 400	7980 ± 800	< 30	117 ± 56
SN-AQI-14C1	05/07/91	Lobster	< 300	3460 ± 420	< 20	< 30
SN-AQI-14C1	05/13/91	Whelk	< 300	2240 ± 400	< 30	< 50
SN-AQI-14C1	10/02/91	Lobster	< 200	2760 ± 300	< 20	< 30
SN-AQI-14C1	10/02/91	Squid	< 300	3610 ± 500	< 30	< 50
SN-AQI-14C1	10/02/91	Lobster	< 300	3260 ± 380	< 30	< 40
SN-AQI-14C1	10/08/91	Whelk	< 400	2660 ± 490	< 30	< 70
SN-AQI-13G2 (cl)	05/08/91	Lobster	< 300	3150 ± 370	< 30	< 50
SN-AQI-13G2 (cl)	05/13/91	Whelk	< 400	1380 ± 380	< 40	< 70
SN-AQI-13G2 (cl)	10/04/91	Lobster	< 300	2360 ± 330	< 30	< 30
SN-AQI-13G2 (cl)	10/04/91	Squid	< 400	3320 ± 730	< 30	< 60
SN-AQI-13G2 (cl)	10/08/91	Whelk	< 300	2310 ± 350	< 30	< 50
Average ± 2 s.d.				**3176 ± 2665**		**117 ± 56**

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.

(cl) Denotes Control Location.

TABLE C-4

CONCENTRATIONS OF GAMMA EMITTERS* IN SEDIMENT SAMPLES

Results in Units of pCi/kg (dry) ± 2 sigma

LOCATION CODE	SAMPLE LOCATION	COLLECTION DATE	K-40	Ra-226	Cs-137	Th-228
SN-AQS-2A4	Beach	05/16/91	2090 ± 220	< 300	< 20	141 ± 15
SN-AQS-2A4	Beach	10/24/91	2610 ± 310	< 400	< 20	186 ± 22
Average ± 2 s.d.			**2350 ± 735**			**164 ± 64**

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.
(c1) Denotes Control Location.

TABLE C-5

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-APT-2A2	SN-APT-3B1	SN-APT-3B2	SN-APT-7B1	SN-APT-11G1 (c1)	AVERAGE ± 2 s.d.
JANUARY 91						
01/02/91-01/08/91	23 ± 4	17 ± 4	16 ± 4	21 ± 4	19 ± 4	19 ± 6
01/08/91-01/15/91	11 ± 3	6 ± 2	< 3 (a)	13 ± 3	11 ± 3	10 ± 6
01/15/91-01/22/91	17 ± 3	13 ± 3	4 ± 2	20 ± 3	21 ± 3	15 ± 14
01/22/91-01/29/91	18 ± 3	20 ± 3	12 ± 3	23 ± 3	19 ± 4	18 ± 8
FEBRUARY						
01/29/91-02/05/91	25 ± 3	26 ± 3	24 ± 3	26 ± 3	28 ± 3	26 ± 3
02/05/91-02/13/91	22 ± 3	21 ± 3	< 3	22 ± 3	20 ± 3	21 ± 2
02/13/91-02/19/91	15 ± 3	15 ± 3	17 ± 3	16 ± 3	14 ± 3	15 ± 2
02/19/91-02/26/91	13 ± 3	12 ± 3	5 ± 2	13 ± 3	13 ± 3	11 ± 7
MARCH						
02/26/91-03/05/91	13 ± 3	< 3 (a)	< 3 (a)	10 ± 3	12 ± 3	12 ± 3
03/05/91-03/12/91	13 ± 3	5 ± 2	20 ± 3	17 ± 3	18 ± 3	16 ± 12
03/12/91-03/19/91	9 ± 3	5 ± 2	< 3 (a)	10 ± 3	9 ± 3	8 ± 4
03/19/91-03/26/91	15 ± 3	7 ± 2	14 ± 3	13 ± 3	11 ± 2	12 ± 6
03/26/91-04/02/91	18 ± 3	12 ± 3	19 ± 3	15 ± 3	14 ± 3	16 ± 6
APRIL						
04/02/91-04/09/91	19 ± 3	17 ± 3	18 ± 3	17 ± 3	16 ± 3	17 ± 2
04/09/91-04/16/91	14 ± 3	12 ± 3	12 ± 3	11 ± 3	13 ± 3	12 ± 2
04/16/91-04/23/91	10 ± 3	9 ± 3	9 ± 3	10 ± 3	8 ± 3	9 ± 1
04/23/91-04/30/91	15 ± 3	15 ± 3	18 ± 3	15 ± 3	12 ± 3	15 ± 4

(a) Confirmed by recount.
(c1) Denotes Control Location.

TABLE C-5 (Cont.)

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-APT-2A2	SN-APT-3B1	SN-APT-6B2	SN-APT-7B1	SN-APT-11G1 (c1)	AVERAGE ± 2 s.d.
MAY						
04/30/91-05/07/91	7 ± 3	9 ± 3	8 ± 3	6 ± 3	8 ± 3	8 ± 2
05/07/91-05/14/91	14 ± 3	15 ± 3	17 ± 3	13 ± 3	16 ± 3	15 ± 3
05/14/91-05/21/91	22 ± 3	16 ± 3	19 ± 3	18 ± 3	19 ± 3	19 ± 4
05/21/91-05/28/91	21 ± 3	23 ± 3	22 ± 3	23 ± 3	24 ± 3	23 ± 2
JUNE						
05/28/91-06/04/91	15 ± 3	13 ± 3	14 ± 3	15 ± 3	16 ± 3	15 ± 2
06/04/91-06/11/91	9 ± 3	6 ± 2	10 ± 3	8 ± 3	8 ± 2	8 ± 3
06/11/91-06/18/91	21 ± 8 (a)	4 ± 2	13 ± 3	16 ± 3	15 ± 3	14 ± 12
06/18/91-06/25/91	13 ± 3	13 ± 3	4 ± 2	11 ± 3	11 ± 3	10 ± 7
06/25/91-07/02/91	21 ± 3	8 ± 2	17 ± 3	18 ± 3	12 ± 3	15 ± 10
JULY						
07/02/91-07/09/91	12 ± 3	5 ± 2	17 ± 3	14 ± 3	11 ± 3	12 ± 9
07/09/91-07/16/91	14 ± 3	6 ± 2	14 ± 3	15 ± 3	16 ± 3	13 ± 8
07/16/91-07/23/91	27 ± 4	27 ± 4	29 ± 4	25 ± 3	24 ± 3	26 ± 4
07/23/91-07/30/91	(b)	13 ± 3	14 ± 3	13 ± 3	16 ± 3	14 ± 3
AUGUST						
07/30/91-08/06/91	14 ± 3	17 ± 3	14 ± 3	14 ± 3	16 ± 3	15 ± 3
08/06/91-08/13/91	10 ± 3	10 ± 3	12 ± 3	11 ± 3	8 ± 3	10 ± 3
08/13/91-08/20/91 (c)	22 ± 4	21 ± 3	16 ± 3	22 ± 4	24 ± 3	21 ± 6
08/20/91-08/27/91	18 ± 4	12 ± 3	16 ± 3	12 ± 5	13 ± 3	14 ± 5
08/27/91-09/03/91	25 ± 3	24 ± 3	24 ± 3	25 ± 3	22 ± 3	24 ± 2

(a) Ruptured vanes jammed motor rotor; partial volume collected.
(b) Pump failure; no sample available.
(c) Several collection dates were 08/13/91 to 08/19/91.
(c1) Denotes Control Location.

TABLE C-5 (Cont.)

CONCENTRATIONS OF GROSS BETA EMITTERS IN WEEKLY AIRBORNE PARTICULATES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-APT-2A2	SN-APT-3B1	SN-APT-6B2	SN-APT-7B1	SN-APT-11G1 (c1)	AVERAGE ± 2 s.d.
SEPTEMBER						
09/03/91-09/10/91	14 ± 4	20 ± 4	20 ± 4	19 ± 3	19 ± 3	18 ± 5
09/10/91-09/17/91	19 ± 3	18 ± 3	20 ± 3	21 ± 3	19 ± 3	19 ± 2
09/17/91-09/24/91	16 ± 3	11 ± 3	14 ± 3	13 ± 3	12 ± 3	13 ± 4
09/24/91-10/01/91	11 ± 3	10 ± 3	11 ± 3	11 ± 3	14 ± 3	11 ± 3
OCTOBER						
10/01/91-10/08/91	28 ± 6	22 ± 3	24 ± 4	24 ± 3	17 ± 3	23 ± 8
10/08/91-10/15/91	22 ± 3	19 ± 3	25 ± 4	18 ± 3	15 ± 3	20 ± 8
10/15/91-10/22/91	16 ± 3	14 ± 3	17 ± 3	17 ± 3	17 ± 3	16 ± 3
10/22/91-10/29/91	31 ± 4	23 ± 4	25 ± 4	35 ± 4	22 ± 3	27 ± 11
NOVEMBER						
10/29/91-11/05/91	22 ± 4	14 ± 3	16 ± 3	18 ± 3	18 ± 3	18 ± 6
11/05/91-11/12/91	20 ± 3	20 ± 3	24 ± 4	24 ± 4	24 ± 4	22 ± 4
11/12/91-11/19/91	19 ± 3	21 ± 3	24 ± 4	22 ± 4	22 ± 3	22 ± 4
11/19/91-11/26/91	10 ± 3	10 ± 3	13 ± 3	6 ± 3	10 ± 3	10 ± 4
11/26/91-12/03/91	19 ± 3	17 ± 3	19 ± 3	20 ± 3	19 ± 3	19 ± 2
DECEMBER						
12/03/91-12/10/91	23 ± 4	22 ± 3	23 ± 4	25 ± 4	23 ± 3	23 ± 2
12/10/91-12/17/91	20 ± 3	21 ± 3	24 ± 3	23 ± 3	19 ± 3	21 ± 4
12/17/91-12/23/91	22 ± 3	17 ± 3	20 ± 3	20 ± 3	19 ± 3	20 ± 4
12/23/91-12/27/91	14 ± 5	20 ± 5	18 ± 5	24 ± 5	19 ± 5	19 ± 7
12/27/91-01/02/92	18 ± 3	24 ± 4	24 ± 4	18 ± 3	18 ± 3	20 ± 7
Average ± 2 s.d.	**17 ± 11**	**15 ± 12**	**17 ± 12**	**17 ± 12**	**16 ± 10**	**16 ± 2**

(c1) Denotes Control Location.

TABLE C-8

CONCENTRATIONS OF GAMMA EMITTERS* IN QUARTERLY COMPOSITE OF AIRBORNE PARTICULATE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

LOCATION CODES	NUCLIDES	FIRST QUARTER 01/02/91-04/02/91	SECOND QUARTER 04/02/91-07/02/91	THIRD QUARTER 07/02/91-10/01/91	FOURTH QUARTER 10/01/91-01/02/92	AVERAGE ± 2 s.d.
SN-APT-2A2	Be-7	59.1 ± 6.3	64.7 ± 7.2	64.2 ± 6.4	95.0 ±10.6	70.8 ± 32.7
	K-40	< 9	< 10	< 10	< 9	-
	Cs-134	< 0.5	< 0.5	< 0.7	< 0.4	-
	Cs-137	< 0.5	< 0.6	< 0.6	< 0.4	-
SN-APT-3B1	Be-7	54.4 ± 6.5	52.2 ± 6.7	54.7 ± 7.1	115 ± 14	69.1 ± 61.3
	K-40	< 9	< 20	< 20	< 10	-
	Cs-134	< 0.4	< 0.6	< 0.6	< 0.7	-
	Cs-137	< 0.5	< 0.6	< 0.7	< 0.6	-
SN-APT-8S2	Be-7	40.9 ± 7.9	80.7 ± 8.1	56.3 ± 7.6	112 ± 12	72.5 ± 62.1
	K-40	< 10	< 8	< 10	< 20	-
	Cs-134	< 0.6	< 0.5	< 0.6	< 0.6	-
	Cs-137	< 0.6	< 0.5	< 0.5	< 0.7	-
SN-APT-7B1	Be-7	64.8 ± 6.5	70.1 ± 7.6	67.0 ± 7.8	91.7 ± 10.6	73.4 ± 24.8
	K-40	< 20	< 30	< 10	< 8	-
	Cs-134	< 0.5	< 0.7	< 0.6	< 0.4	-
	Cs-137	< 0.5	< 0.7	< 0.5	< 0.4	-
SN-APT-11G1	Be-7	81.3 ± 8.1	61.2 ± 7.1	49.3 ± 5.6	117 ± 14	77.2 ± 59.3
(c1)	K-40	< 7	< 10	< 7	< 10	-
	Cs-134	< 0.4	< 0.6	< 0.4	< 0.7	-
	Cs-137	< 0.4	< 0.4	< 0.5	< 0.5	-
Average ± 2 s.d.						**72.8 ± 6.1**

* All other gamma emitters not listed were <LLD; typical LLDs are found in Tables C-13 and C-14.
(c1) Denotes control location.

TABLE C-7

CONCENTRATIONS OF IODINE-131 IN AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-APT-2A2	SN-APT-3S1	SN-APT-8S2	SN-APT-7B1	SN-APT-11G1 (c1)
JANUARY 91					
01/02/90-01/08/91	< 40	< 40	< 40	< 40	< 20
01/08/91-01/15/91	< 20	< 20	< 20	< 20	< 20
01/15/91-01/22/91	< 30	< 30	< 30	< 30	< 20
01/22/91-01/29/91	< 20	< 30	< 30	< 20	< 20
FEBRUARY					
01/29/91-02/05/91	< 20	< 20	< 20	< 20	< 10
02/05/91-02/13/91	< 30	< 30	< 30	< 30	< 20
02/13/91-02/19/91	< 30	< 30	< 30	< 30	< 30
02/19/91-02/26/91	< 20	< 20	< 20	< 20	< 10
MARCH					
02/26/91-03/05/91	< 30	< 30	< 30	< 30	< 20
03/05/91-03/12/91	< 30	< 20	< 20	< 20	< 20
03/12/91-03/19/91	< 20	< 20	< 20	< 20	< 20
03/19/91-03/26/91	< 20	< 10	< 10	< 10	< 8
03/26/91-04/02/91	< 30	< 30	< 30	< 30	< 20
APRIL					
04/02/91-04/09/91	< 30	< 30	< 30	< 30	< 20
04/09/91-04/16/91	< 20	< 20	< 20	< 20	< 20
04/16/91-04/23/91	< 10	< 10	< 10	< 10	< 8
04/23/91-04/30/91	< 10	< 10	< 10	< 10	< 8

(c1) Denotes Control Location.

TABLE C-7 (Cont.)

CONCENTRATIONS OF IODINE-131 IN AIR CARTRIDGE SAMPLES

Results in Units of 10^{-3} pCi/m^3 ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-APT-2A2	SN-APT-3S1	SN-APT-6S2	SN-APT-7B1	SN-APT-11G1 (c)
MAY					
04/30/91-05/07/91	< 30	< 30	< 30	< 30	< 10
05/07/91-05/14/91	< 30	< 30	< 30	< 30	< 20
05/14/91-05/21/91	< 10	< 10	< 10	< 10	< 8
05/21/91-05/28/91	< 30	< 30	< 30	< 30	< 20
JUNE					
05/28/91-06/04/91	< 20	< 20	< 20	< 20	< 10
06/04/91-06/11/91	< 30	< 30	< 30	< 30	< 10
06/11/91-06/18/91	< 60 (a)	< 20	< 20	< 20	< 10
06/18/91-06/25/91 (b)	< 30	< 30	< 30	< 30	< 10

(c) Denotes Control Location.
(a) Sampler malfunction; ruptured vanes jammed motor rotor, partial volume collected.
(b) Analysis for I-131 discontinued after this weekly sample due to REMP program changes.

TABLE C-8

CONCENTRATIONS OF IODINE-131 IN MILK SAMPLES

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	LOCATION CODES SN-GMK-13B1	SN-MLK-8G2 (cl)	SN-GMK-8F2
JANUARY 09, 10	< 0.2	< 0.2	
FEBRUARY 06, 07		< 0.2	
FEBRUARY 10, 11	< 0.2	< 0.2	
MARCH 06, 07		< 0.2	< 0.1
MARCH 13, 14	< 0.3	< 0.3	
APRIL 03, 04	< 0.2	< 0.2	< 0.2
MAY 01, 02	< 0.2	< 0.1	< 0.2
MAY 15, 16	< 0.1	< 0.2	< 0.2
MAY 29, 30	< 0.1	< 0.1	< 0.1
JUNE 12, 13 (a)	< 0.2	< 0.1	< 0.2

GMK Goat's Milk
MILK Cow's Milk
(a) Sampling and analysis discontinued after this collection due to REMP program change.
(cl) Denotes Control Location.

TABLE C-9

CONCENTRATIONS OF GAMMA EMITTERS* IN MILK SAMPLES

Results in Units of pCi/liter ± 2 sigma

COLLECTION DATES	NUCLIDE	LOCATION CODES SN-GMK-13B1	SN-MLK-8G2 (c1)	SN-GMK-8F2
JANUARY 09, 10	K-40	1900 ± 190	890 ± 89	(a)
	Cs-137	< 4	13.7 ± 3.0	
FEBRUARY 06, 07	K-40		882 ± 88	(a)
	Cs-137		2.9 ± 1.3	
FEBRUARY 10, 11	K-40	1280 ± 130	1040 ± 100	(a)
	Cs-137	< 5	14.2 ± 3.3 (b)	
MARCH 06, 07	K-40	(d)	872 ± 87	1340 ± 130
	Cs-137		8.70 ± 3.37 (b)	< 4
MARCH 13, 14	K-40	1730 ± 170	812 ± 81	
	CS-137	< 4	8.11 ± 2.88 (b)	
APRIL 02, 03, 04	K-40	1670 ± 170	1030 ± 100	1460 ± 150
	Cs-137	< 4	10.3 ± 3.5 (b)	< 4
MAY 01, 02	K-40	1660 ± 170	944 ± 94	1560 ± 160
	Cs-137	< 5	9.45 ± 4.28 (b)	< 4
MAY 15, 16	K-40	1790 ± 180	775 ± 77	1540 ± 150
	Cs-137	6.88 ± 3.62 (b)	6.31 ± 3.21 (b)	< 5
MAY 29, 30	K-40	1700 ± 170	877 ± 88	1610 ± 160
	Cs-137	< 5	10.9 ± 3.3 (b)	< 5
JUNE 12, 13 (c)	K-40	1550 ± 150	1140 ± 110	1350 ± 140
	Cs-137	< 4	< 7	< 6

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.
GMK Goat's Milk
MLK Cow's Milk
(a) No goat milk available during the winter due to kidding.
(b) Result confirmed by recount.
(c) Milk sampling and analysis discontinued after this collection due to REMP program change.
(d) Insufficient sample, low production.
(c1) Denotes Control Location.

TABLE C-10

CONCENTRATIONS OF TRITIUM, IODINE-131 AND GAMMA EMITTERS** IN POTABLE WATER

Results in Units of pCi/liter ± 2 sigma

LOCATION CODES	COLLECTION DATE	H-3	I-131*	K-40	Cs-137	Th-228
PWA-2S1	03/21/91	< 100	< 0.1	< 10	< 0.6	< 1
	06/06/91 (a)	< 90	< 0.1	< 100	< 5	< 8
PWA-6B1 (c1)	06/06/91 (a)	< 200	< 0.1	< 100	< 5	< 8
PWA-2A3	03/21/91	< 100	< 0.1	< 20	< 0.7	< 1
	06/06/91 (a)	< 100	< 0.1	< 50	< 4	< 6

* Iodine-131 results are corrected for decay to sample stop date. Determined by radiochemical analysis.
** All other gamma emitters not listed were <LLD; typical LLDs are found in Tables C-13 and C-14.
(a) Sampling and analysis discontinued after this collection due to REMP program change.
(c1) Denotes Control Location.

TABLE C-11

CONCENTRATIONS OF GAMMA EMITTERS* AND I-131 IN FOOD PRODUCT SAMPLES

Results in Units of pCi/kg (wet) ± 2 sigma

LOCATION CODE	SAMPLE TYPE	COLLECTION DATE	K-40	I-131**	Cs-137	Be-7
SN-FPF-5C2	Strawberries	06/12/91	1670 ± 170	< 3 (a)	< 8	< 80
SN-FPL-5C2	Cabbage	08/08/91	2670 ± 270	< 40	< 10	< 100
SN-FPV-5C2	Potatoes	08/08/91	3440 ± 340	< 20	< 7	< 80
SN-FPF-5C2	Peaches	08/08/91	1190 ± 120	< 10	< 5	< 50
SN-FPV-5C2	Corn	08/08/91	2830 ± 280	< 20	< 8	< 70
SN-FPV-6B21	Tomatoes	08/08/91	1520 ± 150	< 20	< 8	< 70
SN-FPL-6B21	Cabbage	09/11/91	1980 ± 200	< 30	< 4	< 40
SN-FPV-6B21	Tomatoes	09/11/91	2590 ± 260	< 40	< 5	< 50
SN-FPF-8B1	Strawberries	06/13/91	1730 ± 170	< 4 (a)	< 10	< 90
SN-FPV-8B1	Corn	07/24/91	2480 ± 250	< 60	< 20	< 200
SN-FPV-8B1	Potatoes	07/24/91	3700 ± 370	< 30	< 9	< 80
SN-FPV-8B1	Carrots	07/24/91	4360 ± 440	< 30	< 10	< 100
SN-FPV-8B1	Tomatoes	07/24/91	1880 ± 190	< 20	< 6	< 50
SN-FPV-8B1	Potatoes	08/08/91	4800 ± 480	< 20	< 9	< 80
SN-FPV-8B1	Tomatoes	08/08/91	1850 ± 180	< 30	< 10	< 100
SN-FPV-8B1	Carrots	08/08/91	4600 ± 460	< 30	< 10	< 100
SN-FPL-8B1	Lettuce	09/11/91	2620 ± 260	< 30	< 4	< 40
SN-FPV-8B1	Potatoes	09/11/91	4410 ± 440	< 60	< 7	< 70
SN-FPV-8B1	Corn	09/11/91	2590 ± 260	< 60	< 7	< 80
SN-FPV-8B1	Carrots	09/11/91	4020 ± 400	< 30	< 4	< 40
SN-FPV-8B1	Tomatoes	09/11/91	1850 ± 180	< 30	< 4	< 40
SN-FPL-8B1	Cabbage	10/23/91	1820 ± 180	< 20	< 7	< 60
SN-FPL-8B1	Lettuce	10/23/91	1820 ± 180	< 20	< 7	< 60
SN-FPV-8B1	Potatoes	10/23/91	4630 ± 460	< 20	< 7	< 60
SN-FPV-8B1	Carrots	10/23/91	4880 ± 490	< 20	< 8	< 70
SN-FPL-8B1	Cabbage	11/14/91	1680 ± 170	< 20	< 10	< 90
SN-FPL-8B1	Lettuce	11/14/91	1840 ± 180	< 20	< 10	131 ± 72
SN-FPL-8B1	Cabbage	11/14/91	3090 ± 310	< 20	< 20	< 100
SN-FPV-8B1	Potatoes		3720 ± 370	< 20	< 8	< 70

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.

** All I-131 results were by Ge(Li) gamma spectrometry except 6/12-6/13/91 samples for which radiochemistry procedures were used.

(c1) Denotes Control Location.

(a) Iodine-131 analysis by radiochemistry was discontinued after this collection due to a REMP program change.

TABLE C-11 (Cont.)

CONCENTRATIONS OF GAMMA EMITTERS* AND I-131 IN FOOD PRODUCT SAMPLES

Results in Units of pCi/kg (wet) ± 2 sigma

LOCATION CODE	SAMPLE TYPE	COLLECTION DATE	K-40	I-131**	Cs-137	Be-7
SN-FPL-12H1 (cl)	Lettuce	07/24/91	2550 ± 250	< 20	< 7	< 70
SN-FPL-12H1	Lettuce	08/07/91	2550 ± 260	< 10	< 6	< 50
SN-FPV-12H1	Tomatoes	08/07/91	3250 ± 330	< 10	< 5	< 40
SN-FPL-12H1	Cabbage	11/14/91	3180 ± 220	< 20	< 9	< 70
SN-FPV-12H1	Potatoes	11/14/91	3530 ± 350	< 20	< 10	< 70
SN-FPF-12H2 (cl)	Strawberries	06/12/91	2090 ± 210	< 3 (a)	< 10	< 90
SN-FPV-12H2	Corn	07/25/91	2920 ± 290	< 30	< 10	< 90
SN-FPV-12H2	Tomatoes	07/25/91	1890 ± 190	< 10	< 6	< 50
SN-FPL-12H2	Lettuce	09/11/91	3350 ± 340	< 30	< 5	< 50
SN-FPV-12H2	Corn	09/11/91	2030 ± 200	< 50	< 7	< 70
SN-FPV-12H2	Tomatoes	09/11/91	2530 ± 250	< 30	< 3	< 40
SN-FPL-12H2	Lettuce	10/23/91	2020 ± 200	< 10	< 6	< 60
SN-FPV-12H2	Potatoes	10/23/91	3880 ± 390	< 20	< 7	< 60
Average ± 2 s.d.			**2786 ± 2053**			**131 ± 72**

* All other gamma emitters not listed were <LLD; typical LLDs are given in Tables C-13 and C-14.

** All I-131 results were by Ce(Li) gamma spectrometry except 6/12-6/13/91 samples for which radiochemistry procedures were used.

(cl) Denotes Control Location.

(a) Iodine-131 analysis by radiochemistry was discontinued after this collection due to a REMP program change.

TABLE C-12

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

mR/standard month*

LOCATION CODES	FIRST QUARTER 01/10/91-04/11/91	SECOND QUARTER 04/11/91-07/11/91	THIRD QUARTER 07/11/91-10/10/91 (a)	FOURTH QUARTER 10/10/91-01/09/92 (a)	ANNUAL AVERAGE (b)
SN-IDM-1S1	3.5 ± 0.1	3.3 ± 0.1	2.9 ± 0.1	3.3 ± 0.4	3.3 ± 0.5
SN-IDM-3S1	3.4 ± 0.2	3.3 ± 0.2	3.4 ± 0.2	3.2 ± 0.4	3.3 ± 0.2
SN-IDM-4S1	4.0 ± 0.8	3.9 ± 0.3	3.5 ± 0.1	3.5 ± 0.2	3.7 ± 0.5
SN-IDM-5S2	3.9 ± 0.5	4.5 ± 0.2	3.5 ± 0.1	3.4 ± 0.4	3.8 ± 1.0
SN-IDM-6S2	3.7 ± 0.6	4.2 ± 0.7	3.3 ± 0.2	3.3 ± 0.3	3.6 ± 0.9
SN-IDM-9S1	3.4 ± 0.3	3.6 ± 0.6	3.4 ± 0.1	3.5 ± 0.2	3.5 ± 0.2
SN-IDM-9S2	3.4 ± 0.1	3.5 ± 0.3			3.5 ± 0.1
SN-IDM-13S3	3.6 ± 0.2	3.9 ± 0.5	3.3 ± 0.2	3.5 ± 0.4	3.6 ± 0.4
SN-IDM-14S2	3.1 ± 0.2	3.0 ± 0.1	2.7 ± 0.2	2.8 ± 0.3	2.9 ± 0.4
SN-IDM-15S1	3.1 ± 0.2	3.3 ± 0.6	2.8 ± 0.2	2.9 ± 0.2	3.0 ± 0.4
SN-IDM-16S2	3.6 ± 0.2	3.5 ± 0.1	3.1 ± 0.4	3.6 ± 0.2	3.5 ± 0.5
SN-IDM-2A2	3.0 ± 0.1	3.2 ± 0.4	2.8 ± 0.1	2.8 ± 0.2	3.0 ± 0.4
SN-IDM-2A3	3.9 ± 0.2	3.8 ± 0.4			3.9 ± 0.1
SN-IDM-6A1	4.6 ± 0.4	5.5 ± 0.8			5.1 ± 1.3
SN-IDM-7A2	3.2 ± 0.2	3.9 ± 0.2	3.1 ± 0.2	3.3 ± 0.5	3.4 ± 0.7
SN-IDM-8A3	3.3 ± 0.2	3.5 ± 0.3	3.4 ± 0.2	3.3 ± 0.5	3.4 ± 0.2
SN-IDM-10A1	3.7 ± 0.3	3.7 ± 0.3	3.2 ± 0.2	3.4 ± 0.0	3.5 ± 0.5
SN-IDM-11A1	3.5 ± 0.1	3.5 ± 0.2	3.2 ± 0.1	3.4 ± 0.3	3.4 ± 0.3
SN-IDM-12A1	4.2 ± 0.2	3.9 ± 0.2	3.6 ± 0.2	3.9 ± 0.4	3.9 ± 0.5
SN-IDM-4B1	3.6 ± 0.4	3.8 ± 0.2			3.7 ± 0.3
SN-IDM-7B1	3.2 ± 0.2	3.2 ± 0.5			3.2 ± 0.0

* The standard month = 30.4 days.

(a) Due to REMP program changes 23 out of the 41 stations were discontinued after the second quarter collection.

(b) The ± limits given in this column define a 95% confidence interval for the mean of the four quarterly results at that location.

TABLE C-12 (Cont.)

DIRECT RADIATION MEASUREMENTS - QUARTERLY TLD RESULTS

mR/standard month*

LOCATION CODES		FIRST QUARTER 01/10/91-04/11/91	SECOND QUARTER 04/11/91-07/11/91	THIRD QUARTER	FOURTH QUARTER	ANNUAL AVERAGE (a)
SN-IDM-7B4		3.9 ± 0.2	3.9 ± 0.2			3.9 ± 0.0
SN-IDM-9B2		3.7 ± 0.2	3.5 ± 0.0			3.6 ± 0.3
SN-IDM-12B2		3.7 ± 0.2	3.5 ± 0.2			3.6 ± 0.3
SN-IDM-5D1		4.5 ± 0.0	4.1 ± 1.2			4.3 ± 0.6
SN-IDM-5D3		3.9 ± 0.5	3.9 ± 0.6			3.9 ± 0.0
SN-IDM-12D1		4.0 ± 0.1	3.9 ± 0.2			4.0 ± 0.1
SN-IDM-5E2		4.0 ± 0.2	4.1 ± 0.4			4.1 ± 0.1
SN-IDM-6E1		3.6 ± 0.3	4.2 ± 0.5			3.9 ± 0.8
SN-IDM-7E1		3.6 ± 0.2	3.3 ± 0.2			3.3 ± 0.1
SN-IDM-8E1		3.6 ± 0.3	3.7 ± 0.4			3.7 ± 0.1
SN-IDM-9E1		3.7 ± 0.3	3.8 ± 0.2			3.8 ± 0.1
SN-IDM-10E1		3.6 ± 0.2	3.9 ± 0.2			3.8 ± 0.4
SN-IDM-11E1		3.2 ± 0.3	3.2 ± 0.3			3.2 ± 0.0
SN-IDM-13E1		3.9 ± 0.3	3.8 ± 0.4			3.9 ± 0.1
SN-IDM-5F3	(cl)	4.3 ± 0.2	4.8 ± 0.2			4.6 ± 0.7
SN-IDM-6G1	(cl)	3.4 ± 0.1	3.8 ± 0.3			3.6 ± 0.6
SN-IDM-8G1	(cl)	3.6 ± 0.3	3.6 ± 0.3			3.6 ± 0.0
SN-IDM-11G1	(cl)	3.6 ± 0.1	3.4 ± 0.3	3.3 ± 0.1	3.4 ± 0.2	3.4 ± 0.3
SN-IDM-12G1	(cl)	3.6 ± 0.4	3.1 ± 0.4	3.1 ± 0.2	3.2 ± 0.1	3.3 ± 0.5
SN-IDM-12G2	(cl)	4.4 ± 0.5	4.1 ± 0.3			4.3 ± 0.4
Average (b)		**3.7 ± 0.8**	**3.7 ± 0.9**	**3.2 ± 0.5**	**3.3 ± 0.5**	**3.5 ± 0.5** (c)

* The standard month = 30.4 days.

(a) The ± limits given in this column define a 95% confidence interval for the mean of the four quarterly results at that location.

(b) The ± limits given in this row define a 95% confidence interval for the mean of all locations for that quarter.

(c) The ± limits given here define a 95% confidence interval for a measurement at any location during any quarter in 1990.

TABLE C-13

TYPICAL LLDs ACHIEVED FOR GAMMA SPECTROMETRY

NUCLIDES	MILK AND WATER (pCi/l)	FISH, GAME AND AQUATIC INVERTEBRATES (pCi/kg wet)	AQUATIC PLANTS (pCi/kg dry)	SOIL AND AQUATIC SEDIMENT (pCi/kg dry)	AIR PARTICULATES (10^{-3} pCi/m^3)
Be-7	60	80	80	200	20
Na-22	7	8	10	30	2
K-40	100	300	300	900	20
Cr-51	50	100	70	200	10
Mn-54	5	7	9	30	2
Co-58	5	8	8	20	2
Fe-59	15	20	15	50	2
Co-60	5	8	9	20	2
Zn-65	10	20	20	60	2
Zr-95	30	10	10	40	2
Nb-95	15	(a)	(a)	(a)	(a)
Mo-99	10	10	10	20	5
Ru-103	7	10	10	30	2
Ru-106	50	60	80	200	10
Ag-110m	7	10	10	40	2
Sb-125	15	20	25	80	4
Te-129m	6	10	10	30	2
I-131	10	10	10	30	10
Te-132	10	6	6	25	2
I-133	10	10	10	40	15
Cs-134	6	7	10	30	2
Cs-136	10	10	10	30	2
Cs-137	6	7	10	30	2
Ba-140	60	10	10	5	5
La-140	15	(a)	(a)	(a)	(a)
Ce-141	10	10	15	30	3
Ce-144	30	40	60	150	7
Ra-226	90	100	150	400	20
Th-228	10	10	25	60	3

(a) No ODCM Requirements.

TABLE C-14

LLD's AND REPORTING ACTION LEVELS - 1991

REQUIRED BY ODCM AND CONTRACT

SAMPLE TYPE			Units	Sr-90	Zr-95	Nb-95	I-131	Xe-133	Cs-134	Cs-137	Ba-140	La-140
WATER												
Potable	LLD*	ODCM	pCi/l	-	30	15	1.0	-	15	18	60	15
Surface	LLD	Contract		2	30	15	0.5	-	15	18	60	15
Precip.	RAL**	ODCM		-	400	400	2	-	30	50	200	200
	RAL	Contract		20	400	400	2	-	30	50	200	200
AIR												
Air Sample	LLD	ODCM	pCi/m^3	-	-	-	.07	-	.05	.06	-	-
	LLD	Contract		.0001	-	-	.07	-	.05	.06	-	-
	RAL	ODCM		-	-	-	0.9	-	10	20	-	-
	RAL	Contract		0.1	-	-	0.9	-	10	20	-	-
MILK												
Milk	LLD	ODCM	pCi/l	-	-	-	1.0	-	15	18	60	15
	LLD	Contract		1	-	-	0.5	-	15	18	60	15
	RAL	ODCM		-	-	-	3	-	60	70	300	300
	RAL	Contract		8	-	-	3	-	60	70	300	300
Aquatic (1)												
Fish												
Invertebrate	LLD	ODCM	pCi/kg	-	-	-	-	-	130	150	-	-
Aquatic Plants/	Contract			5	-	-	-	-	130	150	-	-
Game	RAL	Contract		20	-	-	-	-	1,000	2,000	-	-
FOOD												
Food	LLD	ODCM	pCi/kg	-	-	-	60	-	60	80	-	-
Products	LLD	Contract	(wet)	-	-	-	60	-	60	80	-	-
	RAL	ODCM		-	-	-	100	-	1,000	2,000	-	-
	RAL	Contract		-	-	-	100	-	1,000	2,000	-	-
SEDIMENTS/SOILS												
Sediments	LLD	ODCM	pCi/kg	-	-	-	-	-	150	180	-	-
Soils	LLD	Contract	(dry)	5	-	-	-	-	150	180	-	-
	RAL	ODCM		-	-	-	-	-	-	-	-	-
	RAL	Contract		80	-	-	-	-	1,000	2,000	-	-
NOBLE GAS	LLD	ODCM	pCi/m^3	-	-	-	-	-	-	-	-	-
	LLD	Contract		-	-	-	-	100	-	-	-	-
	RAL	ODCM		-	-	-	-	100	-	-	-	-
	RAL	Contract		-	-	-	-	-	-	-	-	-

* Lower limit of detection

** Reporting action level

(1) There are no ODCM requirements for game or aquatic plants. Aquatic contract LLDs and RALs for gamma spectrometry apply to game and aquatic plants. Sr-89/90 LLDs and RALs for aquatic plants are 30 pCi/kg (dry) and 45 pCi/kg (dry), respectively.

TABLE C-14 (Cont.)

LLD's AND REPORTING ACTION LEVELS - 1991

REQUIRED BY ODCM AND CONTRACT

SAMPLE TYPE	Requirements		Units	Gross Beta	H-3	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Kr-85	Sr-89
ATMOSPHERIC/AIRBORNE												
Air Sample	LLD*	ODCM	pCi/m^3	0.01	-	-	-	-	-	-	-	-
	LLD	Contract		0.01	-	-	-	-	-	-	-	-
	RAL**	ODCM		-	-	-	-	-	-	-	-	.0001
	RAL	Contract		1	-	-	-	-	-	-	-	0.1
AQUATIC												
Fish	LLD	ODCM	pCi/kg	-	-	130	130	260	130	260	-	-
Invertebrate/	LLD	Contract	(wet)	-	-	130	130	260	130	260	-	5
Algae	RAL	ODCM		-	-	30,000	30,000	10,000	10,000	20,000	-	-
	RAL	Contract		-	-	30,000	30,000	10,000	10,000	20,000	-	20
WATERBORNE												
Potable	LLD	ODCM	pCi/l	4	3,000	15	15	30	15	30	-	-
Surface	LLD	Contract		4	200	15	15	30	15	30	-	10
Precip.	RAL	ODCM		-	30,000	1,000	1000	400	300	300	-	-
	RAL	Contract		50	30,000	1,000	1,000	400	300	300	-	20
TERRESTRIAL												
Food	LLD	ODCM	pCi/kg	-	-	-	-	-	-	-	-	-
Products	LLD	Contract	(wet)	-	-	-	-	-	-	-	-	-
	RAL	ODCM		-	-	-	-	-	-	-	-	-
	RAL	Contract		-	-	-	-	-	-	-	-	-
MILK												
Milk	LLD	ODCM	pCi/l	-	-	-	-	-	-	-	-	-
	LLD	Contract		-	-	-	-	-	-	-	-	5
	RAL	ODCM		-	-	-	-	-	-	-	-	-
	RAL	Contract		-	-	-	-	-	-	-	-	20
SEDIMENT/SOILS												
Sediments	LLD	ODCM	pCi/kg	-	-	-	-	-	-	-	-	-
Soils	LLD	Contract	(dry)	-	-	-	-	-	-	-	-	5
	RAL	ODCM		-	-	-	-	-	-	-	-	-
	RAL	Contract		-	-	-	-	-	-	-	-	80
NOBLE GAS	LLD	ODCM	pCi/m^3	-	-	-	-	-	-	-	-	-
	LLD	Contract		-	-	-	-	-	-	-	25	-
	RAL	ODCM		-	-	-	-	-	-	-	-	-
	RAL	Contract		-	-	-	-	-	-	-	-	-
DIRECT	LLD	ODCM		-	-	-	-	-	-	-	-	-
RADIATION	LLD	Contract	1.5 mR/std. month	-	-	-	-	-	-	-	-	-
TLD												

* Lower limit of detection

** Reporting action level

APPENDIX D

ANALYTICAL PROCEDURES SYNOPSIS

ANALYTICAL PROCEDURES SYNOPSIS

Appendix D is a synopsis of the analytical procedures performed on samples collected for the Shoreham Nuclear Power Station's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by Long Island Lighting Company and Teledyne Isotopes and include those recommended by the USNRC Branch Technical Position, Rev. 1, November 1979.

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

1.0 INTRODUCTION

The procedures described in this section are used to measure the overall radioactivity of water samples without identifying the radioactive species present. No chemical separation techniques are involved.

One liter of the sample is evaporated on a hot plate. A smaller volume may be used if the sample has a significant salt content as measured by a conductivity meter. If requested by the customer, the sample is filtered through No. 54 filter paper before evaporation, removing particles greater than 30 microns in size.

After evaporating to a small volume in a beaker, the sample is rinsed into a 2-inch diameter stainless steel planchet which is stamped with a concentric ring pattern to distribute residue evenly. Final evaporation to dryness takes place under heat lamps.

Residue mass is determined by weighing the planchet before and after mounting the sample. The planchet is counted for beta activity on an automatic proportional counter. Results are calculated using empirical self-absorption curves which allow for the change in effective counting efficiency caused by the residue mass.

2.0 DETECTION CAPABILITY

Detection capability depends upon the sample volume actually represented on the planchet, the background and the efficiency of the counting instrument, and upon self-absorption of beta particles by the mounted sample. Because the radioactive species are not identified, no decay corrections are made and the reported activity refers to the counting time.

The minimum detectable level (MDL) for water samples is nominally 1.6 picocuries per liter for gross beta at the 4.66 sigma level (1.0 pCi/l at the 2.83 sigma level), assuming that 1 liter of sample is used and that $\frac{1}{2}$ gram of sample residue is mounted on the planchet. These figures are based upon a counting time of 50 minutes and upon representative values of counting efficiency and background of 0.2 and 1.2 cpm, respectively.

The MDL becomes significantly lower as the mount weight decreases because of reduced self-absorption. At a zero mount weight, the 4.66 sigma MDL for gross beta is 0.9 picocuries per liter. These values reflect a beta counting efficiency of 0.38.

GROSS BETA ANALYSIS OF SAMPLES

Airborne Particulates

After a delay of five or more days, allowing for the radon-222 and radon-220 (thoron) daughter products to decay, the filters are counted in a gas-flow proportional counter. An unused air particulate filter, supplied by LILCO, is counted as the blank.

Calculations of the results, the two sigma error and the lower limit of detection (LLD):

RESULT (pCi/m^3) = $((S/T) - (B/t))/(2.22\ V\ E)$

TWO SIGMA ERROR (pCi/m^3) = $2((S/T^2) + (B/t^2))^{1/2}/(2.22\ V\ E)$

LLD (pCi/m^3) = $4.66\ (B^{1/2})/(2.22\ V\ E\ t)$

where:

S = Gross counts of sample including blank
B = Counts of blank
E = Counting efficiency
T = Number of minutes sample was counted
t = Number of minutes blank was counted
V = Sample aliquot size (cubic meters)

ANALYSIS OF SAMPLES FOR TRITIUM

Water

Approximately 2 ml of water are converted to hydrogen by passing the water, heated to its vapor state, over a granular zinc conversion column heated to 400° C. The hydrogen is loaded into a one liter proportional detector and the volume is determined by recording the pressure.

The proportional detector is passively shielded by lead and steel and an electronic, anticoincidence system provides additional shielding from cosmic rays.

Calculation of the result, the two sigma error and the lower limit detection (LLD) [illegible]

$$\text{RESULT} = 3.234\ T_N\ V_N(C_G - B)/(C_N\ V_S)$$

$$\text{TWO SIGMA ERROR} = 2((C_G + B)\Delta t)^{1/2} 3.234\ T_N\ V_N/((C_N\ V_S)\ (C_G - B))$$

$$\text{LLD} = 4.66\ (3.234) T_N\ V_N (C_G)^{1/2}/(\Delta t\ C_N\ V_S)$$

where:

T_N	=	tritium units of the standard
3.234	=	conversion factor changing tritium units to pCi/l
V_N	=	volume of the standard used to calibrate the efficiency of the detector in psia
V_S	=	volume of the sample loaded into the detector in psia
C_N	=	the cpm activity of the standard of volume V_N
C_G	=	the gross activity in cpm of the sample of volume V_S and the detector volume
B	=	the background of the detector in cpm
Δt	=	counting time for the sample

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, reduced with hydroxylamine hydrochloride and extracted into carbon tetrachloride as free iodine. It is then back-extracted as iodide into sodium bisulfite solution and is precipitated as palladium iodide. The precipitate is weighed for chemical yield and is mounted on a nylon planchet for low level beta counting. The chemical yield is corrected by measuring the stable iodide content of the milk or the water with a specific ion electrode.

Calculations of results, two sigma error and the lower limit of detection (LLD) in pCi/l:

RESULT = $(N/\Delta t - B)/(2.22\ E\ V\ Y\ DF)$

TWO SIGMA ERROR = $2((N/\Delta t + B)/\Delta t)^{1/2}(2.22\ E\ V\ Y\ DF)$

LLD = $= 4.66(B/\Delta t)^{1/2}/(2.22\ E\ V\ Y\ DF)$

where:

N	=	total counts from sample (counts)
Δt	=	counting time for sample (min)
B	=	background rate of counter (cpm)
2.22	=	dpm/pCi
V	=	volume or weight of sample analyzed
Y	=	chemical yield of the mount or sample counted
DF	=	decay factor from the collection to the counting date
E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
E	=	$E_S(\exp -0.0061M)/(\exp -0.0061M_S)$
E_S	=	efficiency of the counter determined from an I-131 standard mount
Ms	=	mass of PdI_2 on the standard mount, mg
M	=	mass of PdI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

A 1.0 liter Marinelli beaker is filled with a representative aliquot of the sample. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Dried Solids Other Than Soils and Sediments

A large quantity of the sample is dried at a low temperature, less than 100°C. As much as possible (up to the total sample) is loaded into a tared 1-liter Marinelli and weighed. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Fish

As much as possible (up to the total sample) of the edible portion of the sample is loaded into a tared Marinelli and weighed. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Soils and Sediments

Soils and sediments are dried at a low temperature, less than 100°C. The soil or sediment is loaded fully into a tared, standard 300 cc container and weighed. The sample is then counted for approximately six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height and analysis.

Charcoal Cartridges (Air Iodine)

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a Ge(Li) detector and up to four on the side of the Ge(Li) detector. Each Ge(Li) detector is calibrated for both positions. The detection limit for I-131 of each charcoal cartridge can be determined (assuming no positive I-131) uniquely from the volume of air which passed through it. In the event I-131 is observed in the initial counting of a set, each charcoal cartridge is then counted separately, positioned on the face of the detector.

Airborne Particulates

The thirteen airborne particulate filters for a quarterly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

A mini-computer software program defines peaks by certain changes in the slope of the spectrum. The program also compares the energy of each peak with a library of peaks for isotope identification and then performs the radioactivity calculation using the appropriate fractional gamma ray abundance, half life, detector efficiency, and net counts in the peak region. The calculation of results, two sigma error and the lower limit of detection (LLD) in pCi/volume of pCi/mass:

RESULT = $(S-B)/2.22\ t\ E\ V\ F\ DF)$

TWO SIGMA ERROR = $2(S+B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$

LLD = $4.66(B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$

where:

S = Area, in counts, of sample peak and background (region of spectrum of interest)

B = Background area, in counts, under sample peak, determined by a linear interpolation of the representative backgrounds on either side of the peak

t = length of time in minutes the sample was counted

2.22 = dpm/pCi

E = detector efficiency for energy of interest and geometry of sample

V = sample aliquot size (liters, cubic meters, kilograms, or grams)

F = fractional gamma abundance (specific for each emitted gamma)

DF = decay factor from the mid-collection date to the counting date

ENVIRONMENTAL DOSIMETRY

Teledyne Isotopes uses a $CaSO_4$:Dy thermoluminescent dosimeter (TLD) which the company manufactures. This material has a high light output, negligible thermally induced signal loss (fading), and negligible self dosing. The energy response curve (as well as all other features) satisfies NRC Reg. Guide 4.13. Transit doses are accounted for by use of separate TLDs.

Following the field exposure period the TLDs are placed in a Teledyne Isotopes Model 8300. One fourth of the rectangular TLD is heated at a time and the measured light emission (luminescence) is recorded. The TLD is then annealed and exposed to a known Cs-137 dose; each area is then read again. This provides a calibration of each area of each TLD after every field use. The transit controls are read in the same manner.

Calculations of results and the two sigma error in net milliRoentgen (mR):

RESULT = $D = (D_1+D_2+D_3+D_4)/4$

TWO SIGMA ERROR = $2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$

WHERE:

D_1 = the net mR of area 1 of the TLD, and similarly for D_2, D_3, and D_4

D_1 = $I_1 K/R_1 - A$

I_1 = the instrument reading of the field dose in area 1

K = the known exposure by the Cs-137 source

R_1 = the instrument reading due to the Cs-137 dose on area 1

A = average dose in mR, calculated in similar manner as above, of the transit control TLDs

D = the average net mR of all 4 areas of the TLD.

APPENDIX E

SUMMARY OF EPA INTERLABORATORY COMPARISONS

US EPA INTERLABORATORY COMPARISON PROGRAM 1991

(Environmental)

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Isotopes Result(b)		
01/11/91	Water	Sr-89	5.00 ±	5.0	5.00 ±	0.00	
		Sr-90	5.00 ±	5.0	5.00 ±	0.00	
01/25/91	Water	Gr-Alpha	5.0 ±	5.0	9.00 ±	1.00	
		Gr-Beta	5.0 ±	5.0	7.00 ±	0.00	
02/08/91	Water	Co-60	40.0 ±	5.0	39.33 ±	3.06	
		Zn-65	149.0 ±	15.0	147.00 ±	1.00	
		Ru-106	186.0 ±	19.0	176.67 ±	17.56	
		Cs-134	8.0 ±	5.0	7.33 ±	0.58	
		Cs-137	8.0 ±	5.0	7.67 ±	3.21	
		Ba-133	75.0 ±	8.0	75.67 ±	5.51	
02/15/91	Water	I-131	75.0 ±	8.0	80.00 ±	5.29	
02/22/91	Water	H-3	4418.0 ±	442.0	4500.0 ±	173.21	
03/08/91	Water	Ra-226	31.8 ±	4.8	28.33 ±	4.73	
		Ra-228	21.1 ±	5.3	16.67 ±	2.08	
03/29/91	Air Filter	Gr-Alpha	25.0 ±	6.0	42.67 ±	0.58	(c)
		Gr-Beta	124.0 ±	6.0	126.67 ±	5.77	
		Sr-90	40.0 ±	5.0	37.00 ±	1.00	
		Cs-137	40.0 ±	5.0	43.00 ±	5.29	
04/16/91	Lab Perf. Water	Gr-Alpha	54.0 ±	14.0	59.67 ±	4.04	
		Ra-226	8.0 ±	1.2	7.33 ±	0.81	
		Ra-228	15.2 ±	3.8	10.00 ±	0.00	(d)
		Gr-Beta	115.0 ±	17.0	110.00 ±	0.00	
		Sr-89	28.0 ±	5.0	31.00 ±	1.00	
		Sr-90	26.0 ±	5.0	21.00 ±	0.00	
		Cs-134	24.0 ±	5.0	25.00 ±	1.00	
		Cs-137	25.0 ±	5.0	24.00 ±	1.73	
04/26/91	Milk	Sr-89	32.0 ±	5.0	24.00 ±	3.00	(e)
		Sr-90	32.0 ±	5.0	26.33 ±	2.08	
		I-131	60.0 ±	6.0	53.33 ±	2.31	
		Cs-137	49.0 ±	5.0	52.67 ±	1.53	
		K	1650.0 ±	83.0	1590.00 ±	81.85	

See footnotes at end of table.

US EPA INTERLABORATORY COMPARISON PROGRAM 1991

(Environmental)

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Isotopes Result(b)		
05/10/91	Water	Sr-89	39.0 ±	5.0	38.67 ±	4.51	
		Sr-90	24.0 ±	5.0	22.00 ±	1.73	
05/17/91	Water	Gr-Alpha	24.0 ±	6.0	24.33 ±	2.52	
		Gr-Beta	46.0 ±	5.0	50.33 ±	1.53	
06/07/91	Water	Co-60	10.0 ±	5.0	10.33 ±	0.58	
		Zn-65	108.0 ±	11.0	106.00 ±	2.65	
		Ru-106	149.0 ±	15.0	136.67 ±	3.79	
		Cs-134	15.0 ±	5.0	13.67 ±	1.53	
		Cs-137	14.0 ±	5.0	13.67 ±	1.53	
		Ba-133	62.0 ±	6.0	56.33 ±	1.53	
06/21/91	Water	H-3	12480 ±	1248.0	12833.33 ±	115.50	
07/12/91	Water	Ra-226	15.9 ±	2.4	15.0 ±	1.00	
		Ra-228	16.7 ±	4.2	14.33 ±	2.31	
08/09/91	Water	I-131	20.0 ±	6.0	19.33 ±	0.58	
08/30/91	Air Filter	Gr-Alpha	25.0 ±	6.0	27.00 ±	2.00	
		Gr-Beta	92.0 ±	10.0	100.00 ±	0.00	
		Sr-90	30.0 ±	5.0	27.67 ±	2.89	
		Cs-137	30.0 ±	5.0	33.33 ±	3.21	
09/13/91	Water	Sr-89	49.0 ±	5.0	50.67 ±	2.89	
		Sr-90	25.0 ±	5.0	26.00 ±	1.00	
09/20/91	Water	Gr-Alpha	10.0 ±	5.0	11.67 ±	0.58	
		Gr-Beta	20.0 ±	5.0	21.00 ±	0.00	
09/27/91	Milk	Sr-89	25.0 ±	5.0	21.00 ±	2.65	
		Sr-90	25.0 ±	5.0	19.00 ±	0.00	(e)
		I-131	108.0 ±	11.0	113.33 ±	5.77	
		Cs-137	30.0 ±	5.0	29.00 ±	3.61	
		K	1740.0 ±	87.0	1503.33 ±	75.06	(f)

See footnotes at end of table.

US EPA INTERLABORATORY COMPARISON PROGRAM 1991

(Environmental)

Collection Date	Media	Nuclide	EPA Result(a)		Teledyne Isotopes Result(b)		
10/04/91	Lab Perf. Water	Co-60	29.0 ±	5.0	30.33 ±	2.08	
		Zn-65	73.0 ±	7.0	72.67 ±	7.09	
		Ru-106	199.0 ±	20.0	197.67 ±	7.51	
		Cs-134	10.0 ±	5.0	10.33 ±	0.58	
		Cs-137	10.0 ±	5.0	11.33 ±	0.58	
		Ba-133	98.0 ±	10.0	97.00 ±	8.72	
10/18/91	Water	H-3	2454.0 ±	353.0	2333.33 ±	57.74	
10/22/91	Lab Perf. Water	Gr-Alpha	82.0 ±	21.0	55.00 ±	4.36	(g)
		Ra-226	22.0 ±	3.3	21.00 ±	2.65	
		Ra-228	22.2 ±	5.6	18.00 ±	1.00	
		Gr-Beta	65.0 ±	10.0	56.00 ±	1.00	
		Sr-89	10.0 ±	5.0	10.67 ±	2.08	
		Sr-90	10.0 ±	5.0	9.33 ±	0.58	
		Co-60	20.0 ±	5.0	19.67 ±	0.58	
		Cs-134	10.0 ±	5.0	10.33 ±	2.08	
		Cs-137	11.0 ±	5.0	13.67 ±	0.58	
11/08/91	Water	Ra-226	6.5 ±	1.0	5.37 ±	0.32	
		Ra-228	8.1 ±	2.0	7.90 ±	1.20	

See footnotes at end of table.

Footnotes:

(a) EPA Results - Expected laboratory precision (1 sigma). Units are pCi/liter for water and milk except K is in mg/liter. Units are total pCi for air particulate filters.

(b) Teledyne Results - Average ± one sigma. Units are pCi/liter for water and milk, except K is in mg/liter. Units are total pCi for air particulate filters.

(c) The sample presents a different counting geometry. The EPA deposits activity in a 3/4 inch diameter circle, on a plastic disk approximately 3/32 inch thick. A special calibration for EPA filters will be performed. The laboratory has obtained blank filters from the Las Vegas facility, and will simulate their deposits. (Note: Gross alpha measurement is not required under the SNPS REMP, but is part of EPA's program requirement.)

(d) The lowest three results out of nine analyses were chosen. Other results in the group were close to the given value. Subsequent EPA analyses were accepted without selection, leading to acceptable results. (Note: Ra-228 is a naturally occurring radioisotope and is not attributable to SNPS.)

(e) The cause for the deviation is believed to be erroneously high strontium yields, probably caused by incomplete separation of calcium. The laboratory has investigated carrier concentrations and pipeting techniques, and have found them to be correct. Further aspects of analysts' techniques are being tested. The laboratory has received a new strontium extraction material developed at Argonne National Laboratory. Experiments with this method to achieve better separation of calcium were completed and procedure PRO-032-105 was implemented on 2/1/92. (Note: Sr-89 analysis was not required for SNPS milk samples in 1991, but is part of EPA's program requirement.)

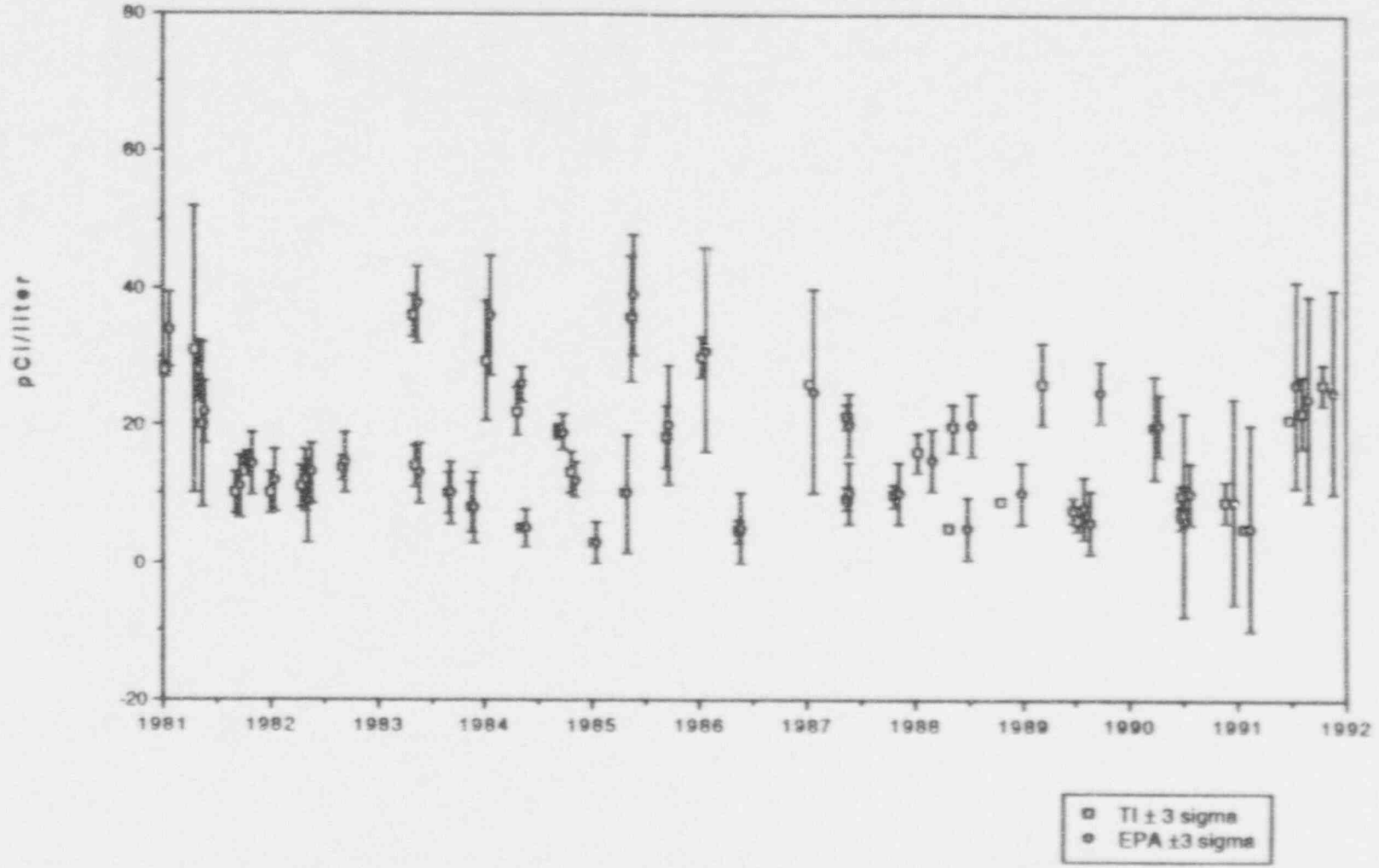
(f) There is no apparent cause for the low K-40 results. Two other isotopes spiked in the sample were in good agreement with EPA values. Unit conversions were reviewed and found to be correctly applied. Possible background errors in geometry were investigated and found to have an insignificant effect. (Note: Sr-90 analysis and gross alpha measurement were not required under the SNPS REMP in 1991, but is part of EPA's program requirement.)

(g) Probable failure to transfer all sample residue to the counting planchet. Analysts are being tested using in-house and other EPA spikes. (Note: Gross alpha measurement is not required under the SNPS REMP, but is part of EPA's program requirement.)

4/23/92

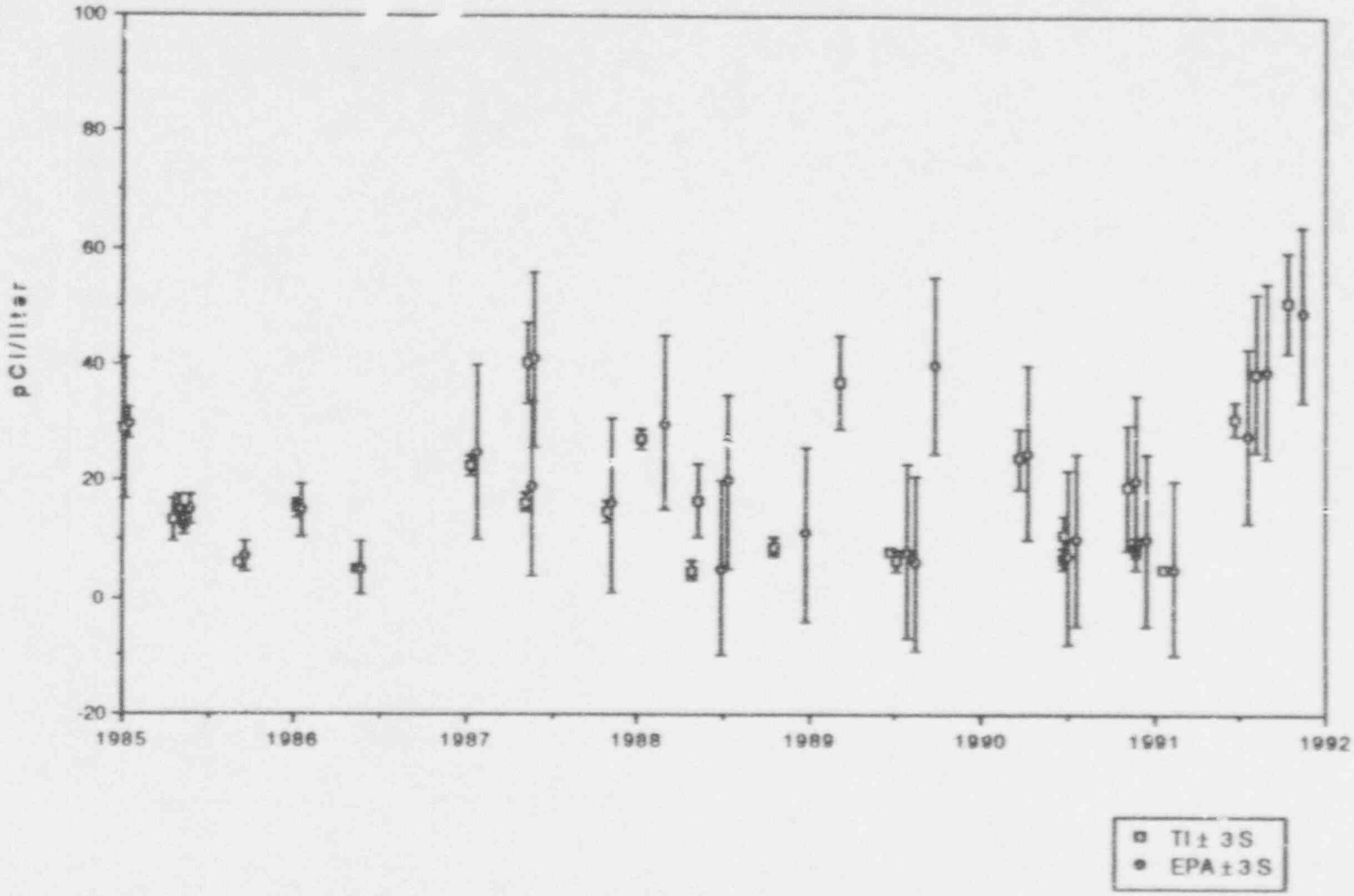
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN WATER



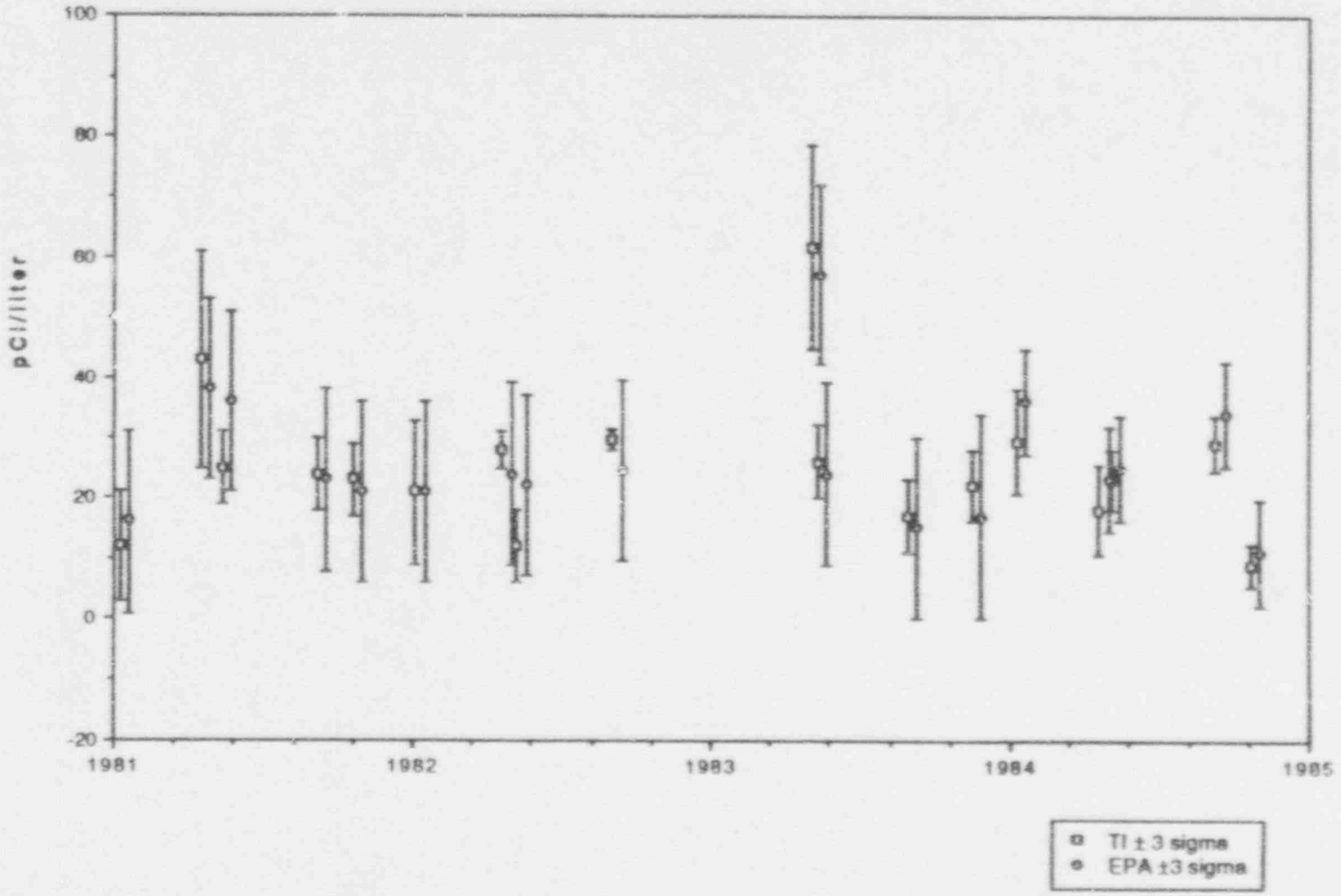
US EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER (Cont.)



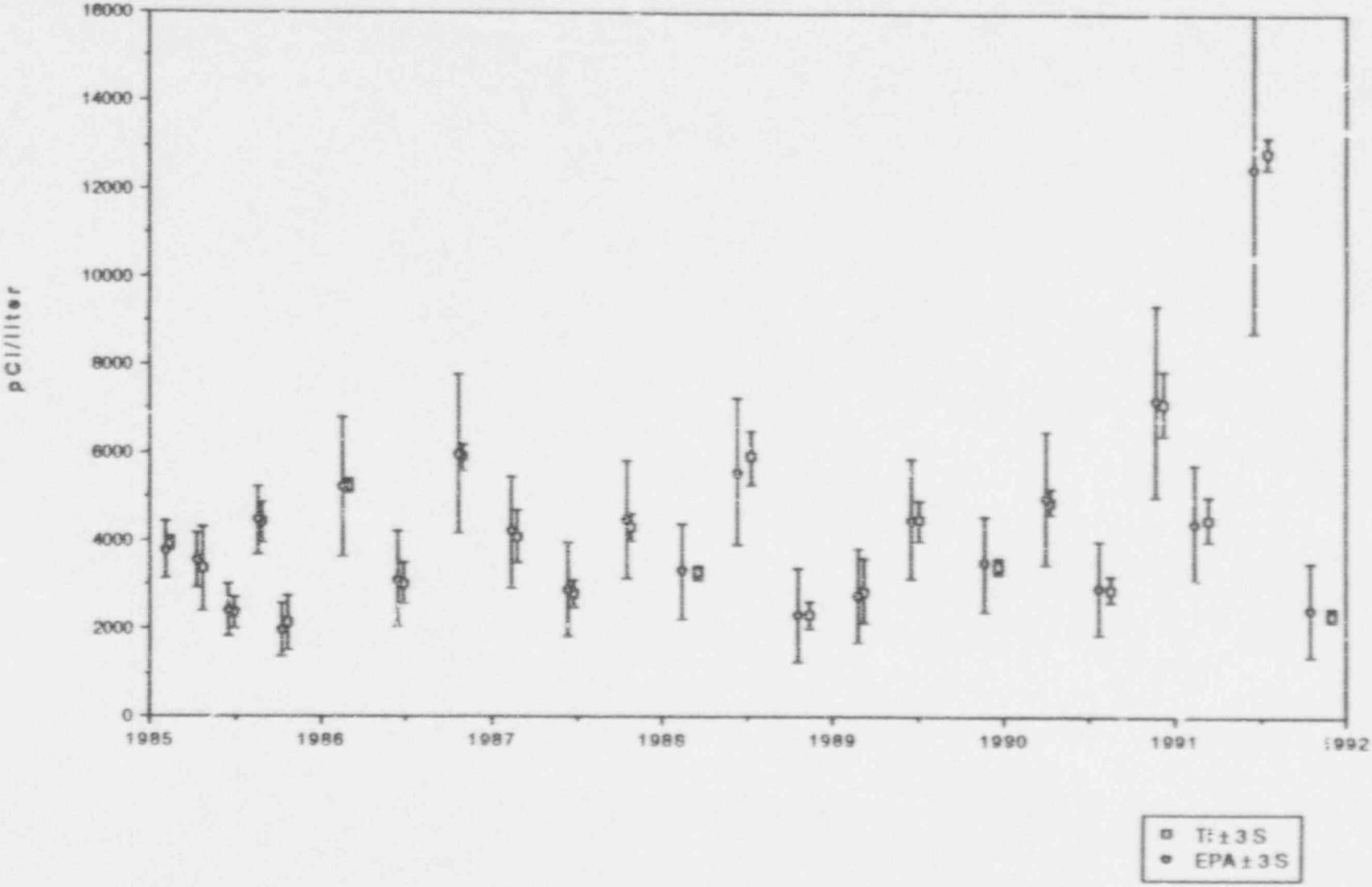
US EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER



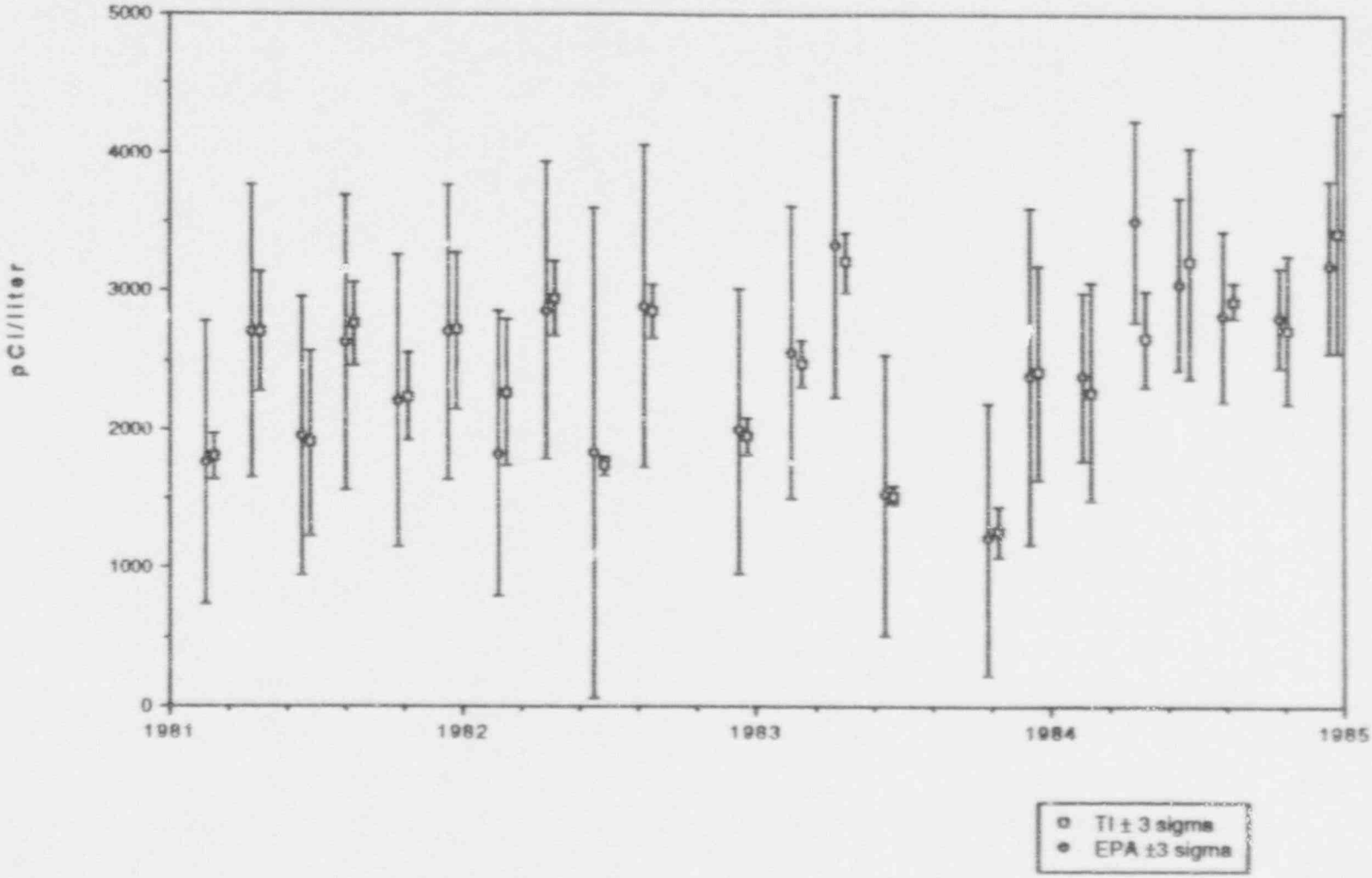
US EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (Cont.)



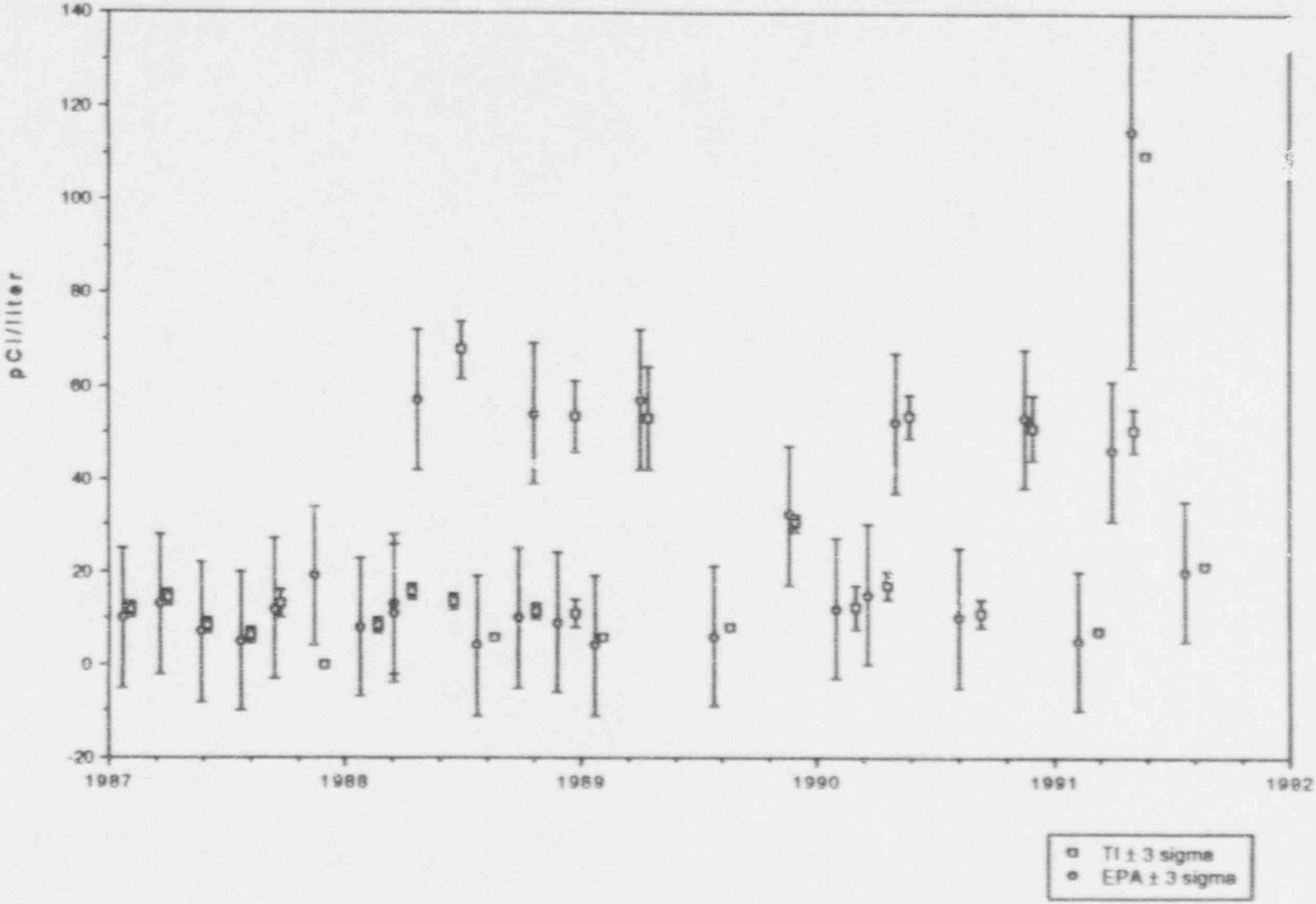
US EPA CROSS CHECK PROGRAM

TRITIUM IN WATER



US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (Cont.)



US EPA CROSS CHECK PROGRAM

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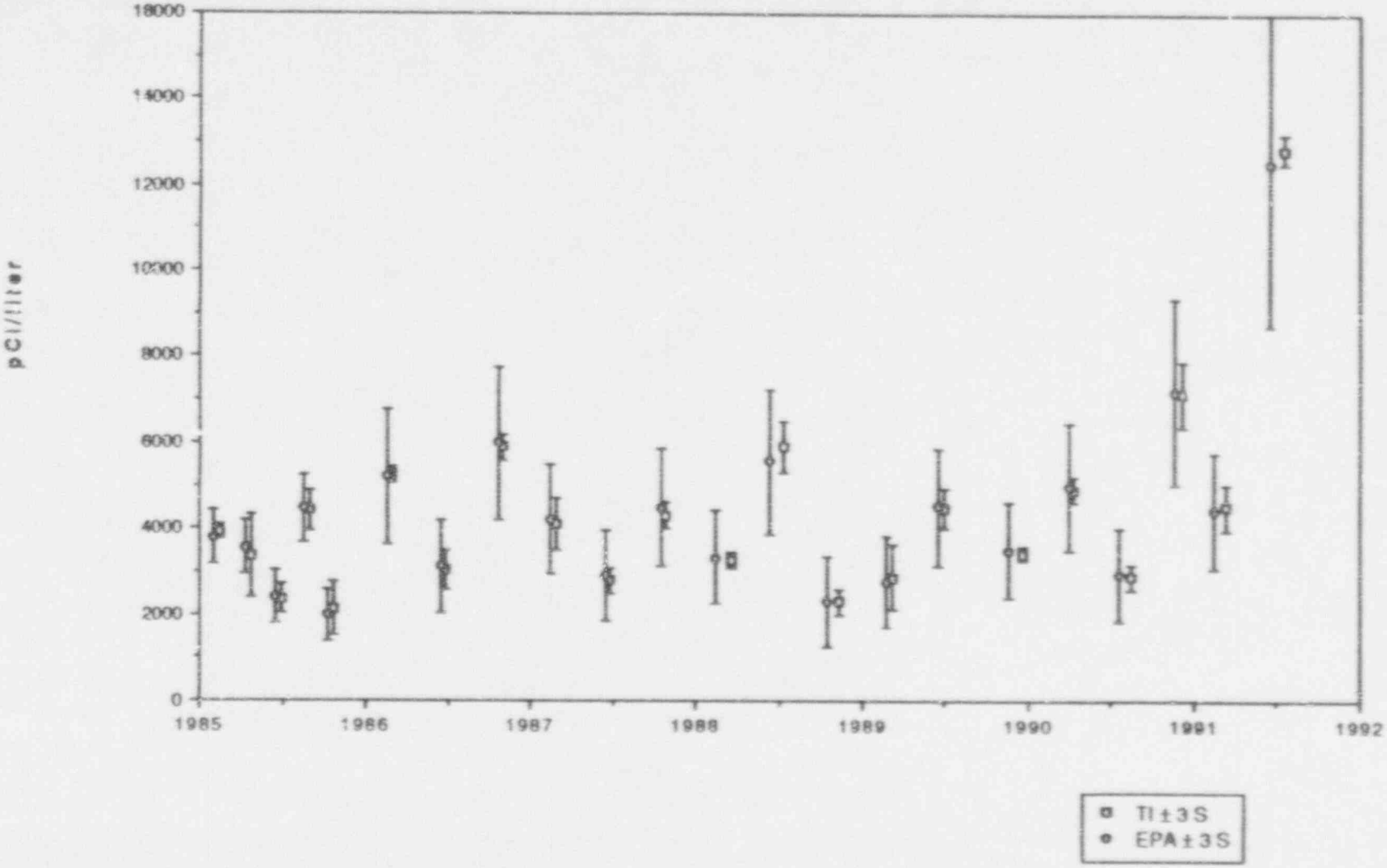
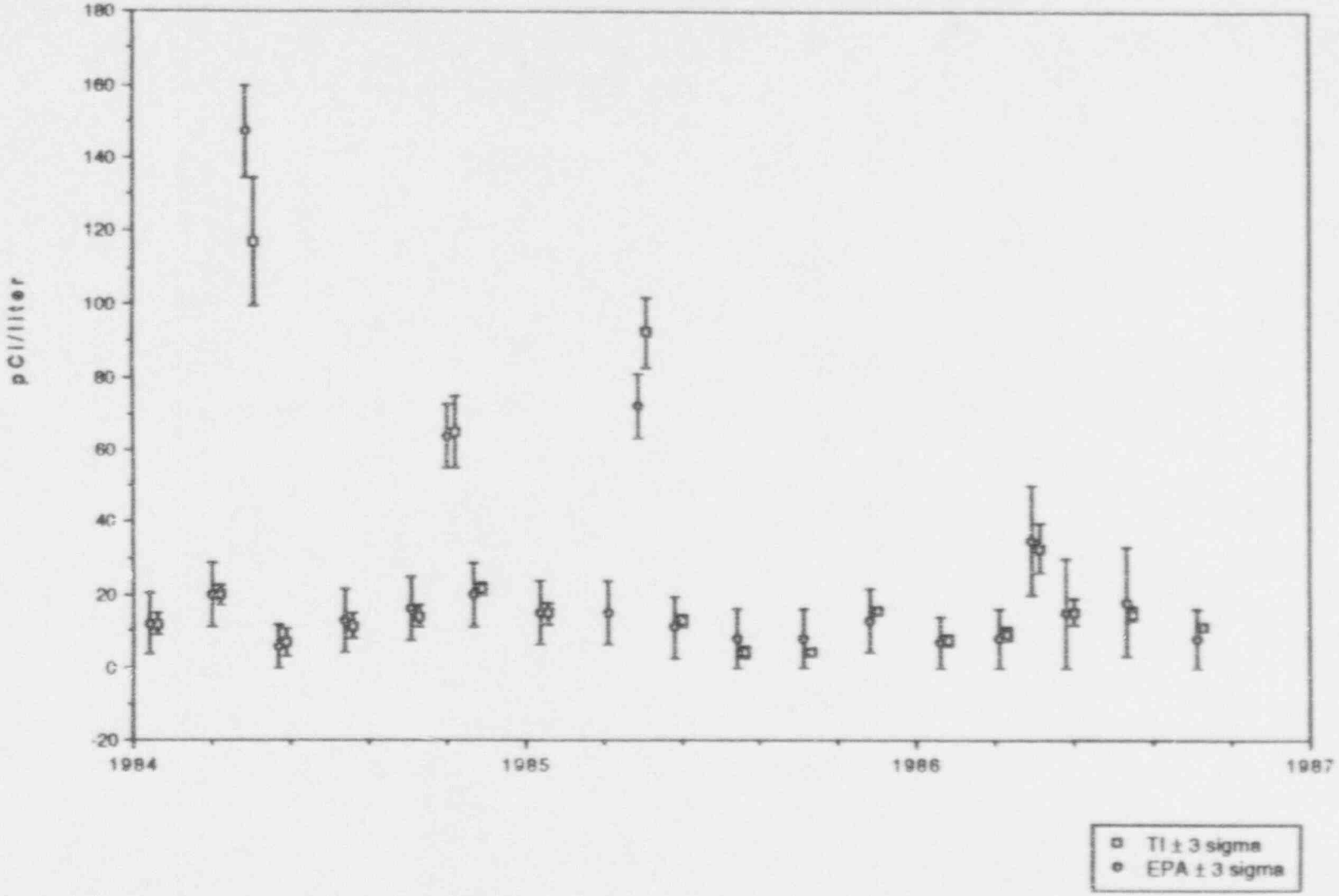


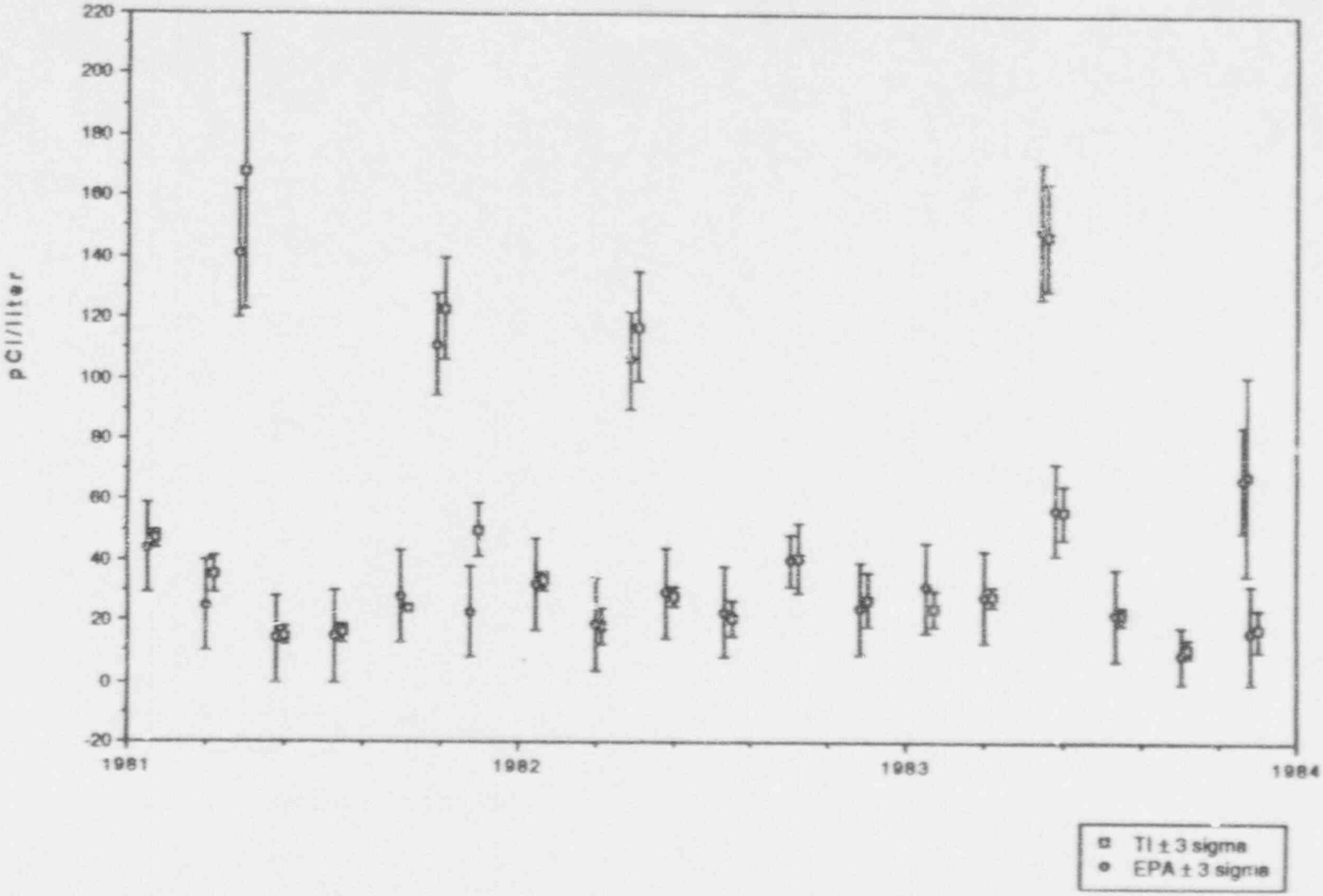
US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER



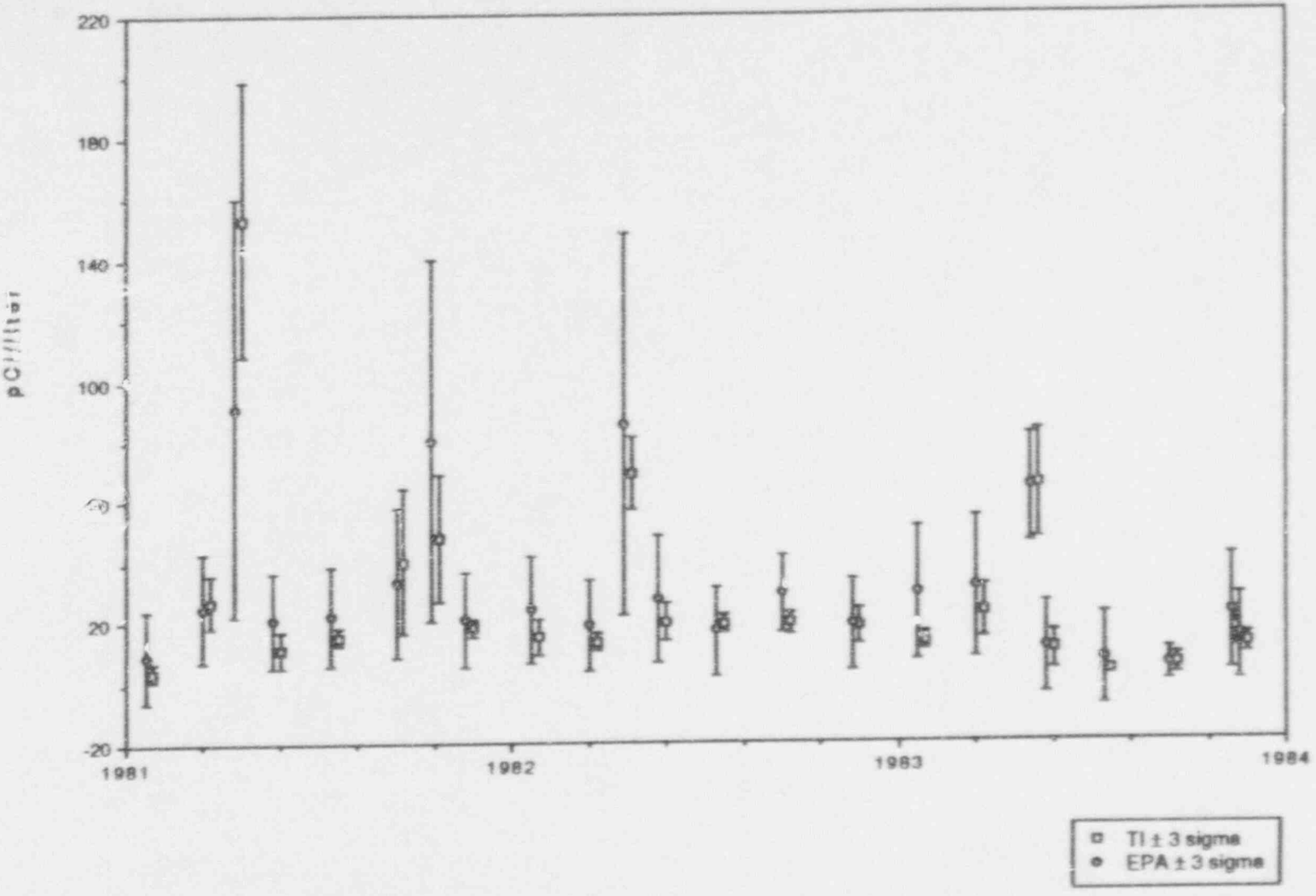
US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER



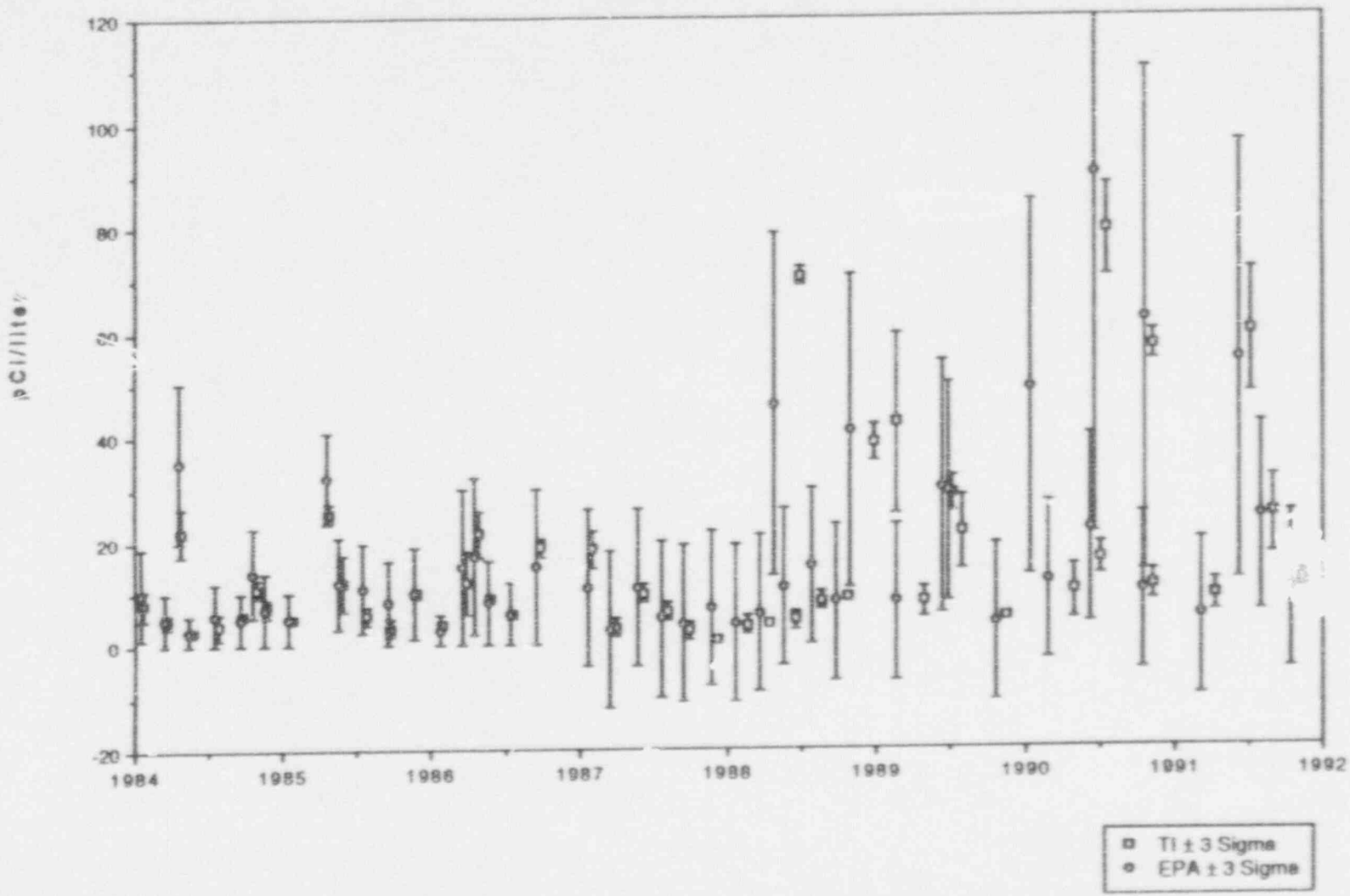
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER



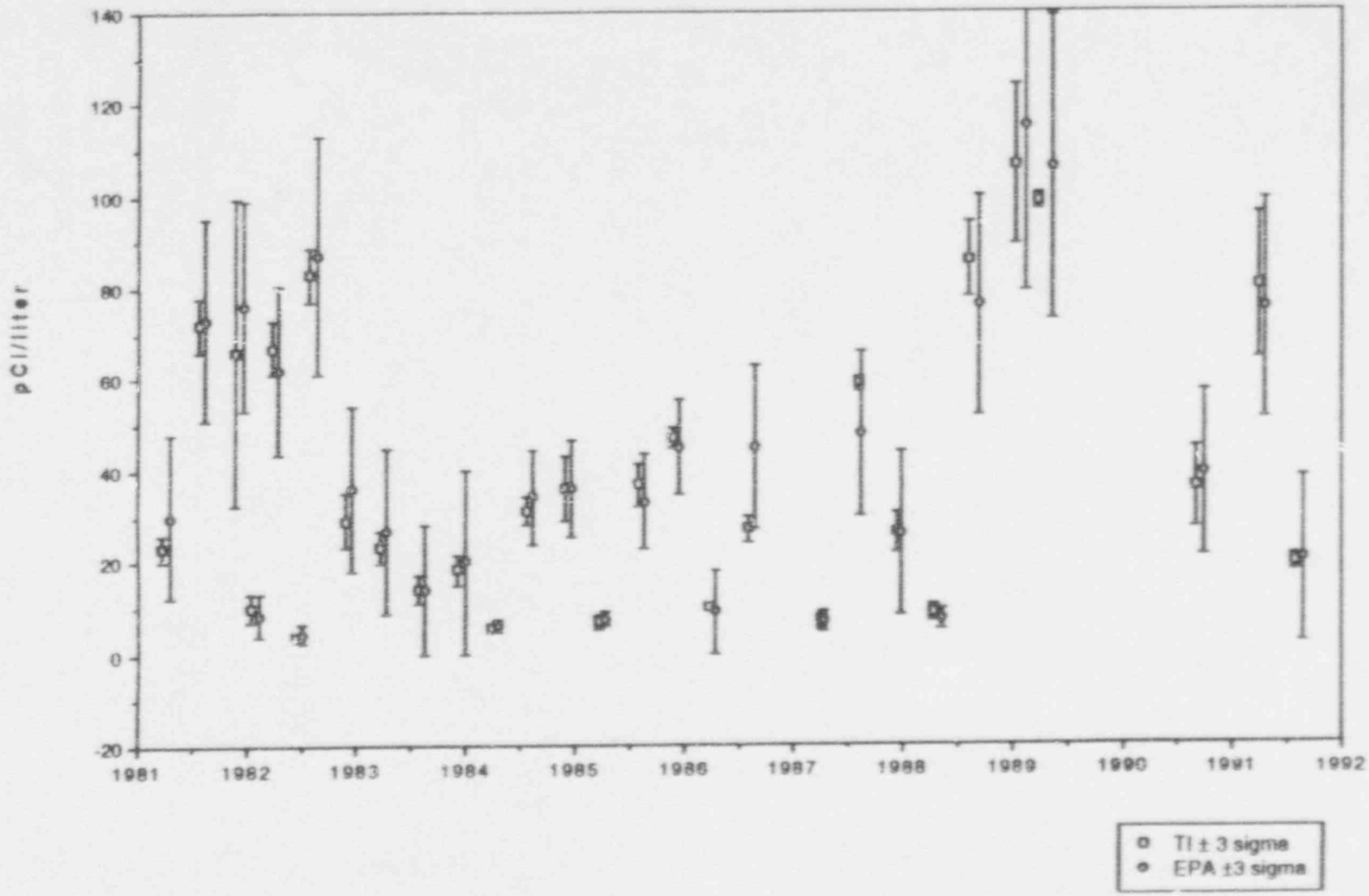
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER



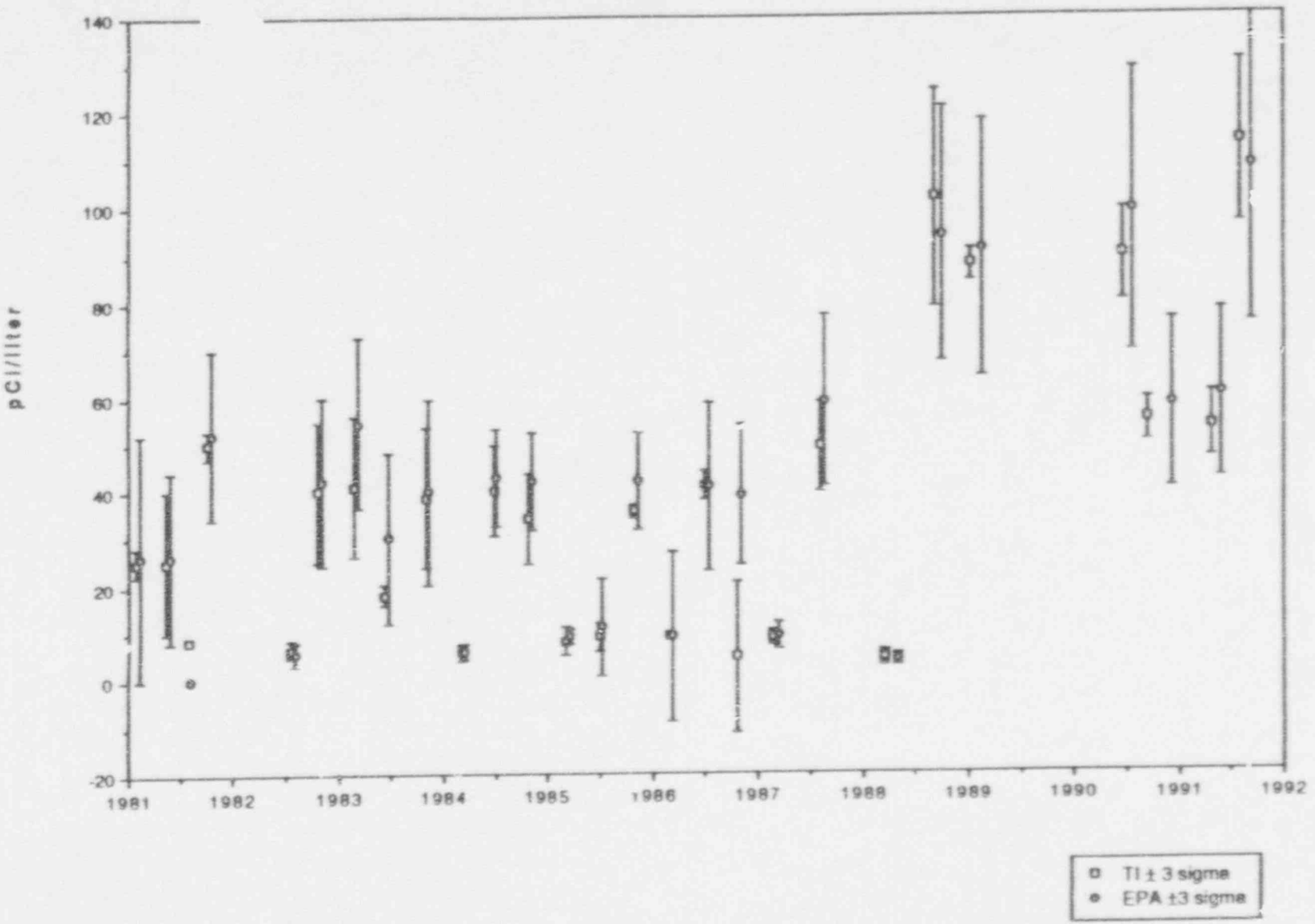
US EPA CROSS CHECK PROGRAM

IODINE-131 IN WATER



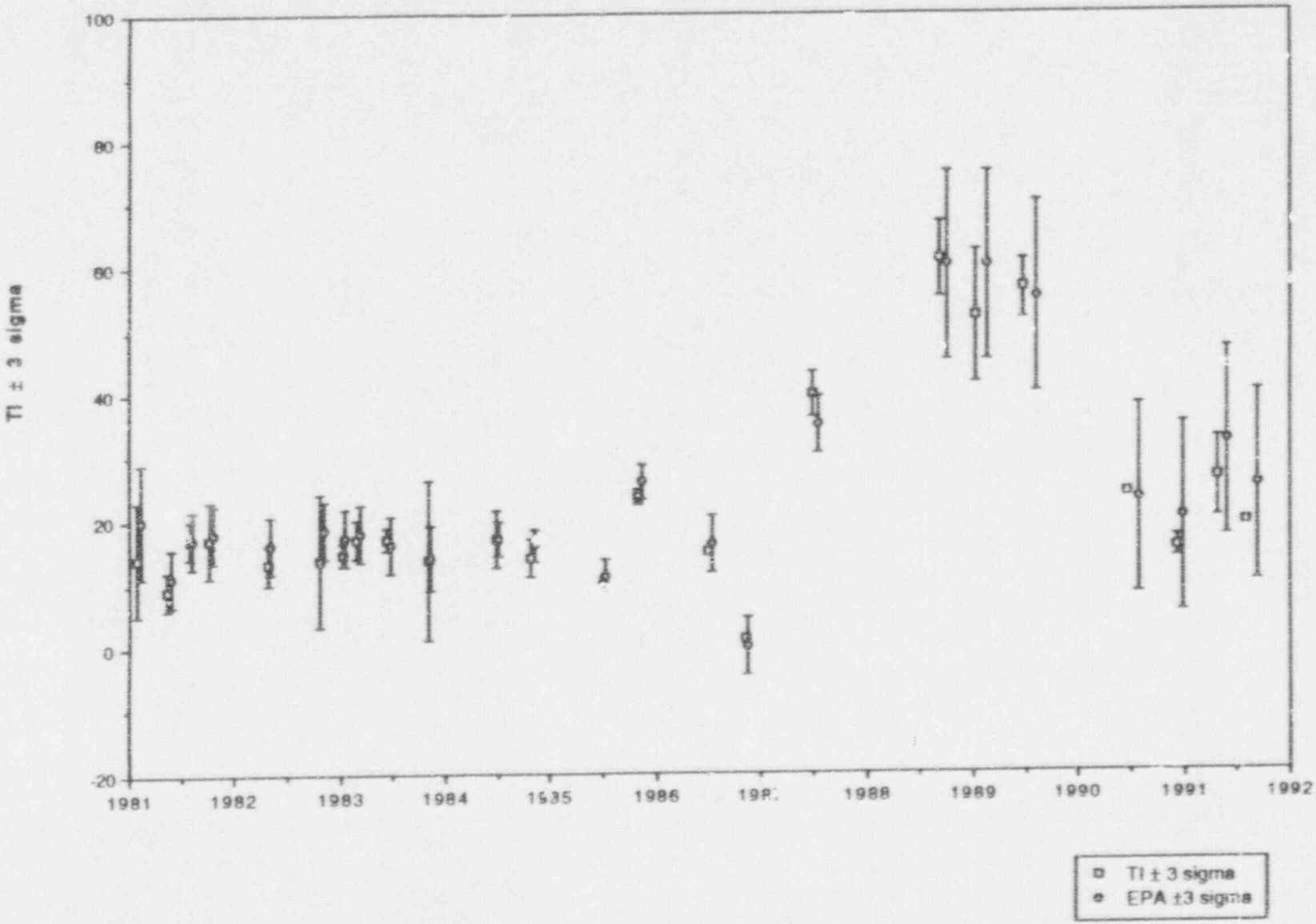
US EPA CROSS CHECK PROGRAM

IODINE-131 IN MILK



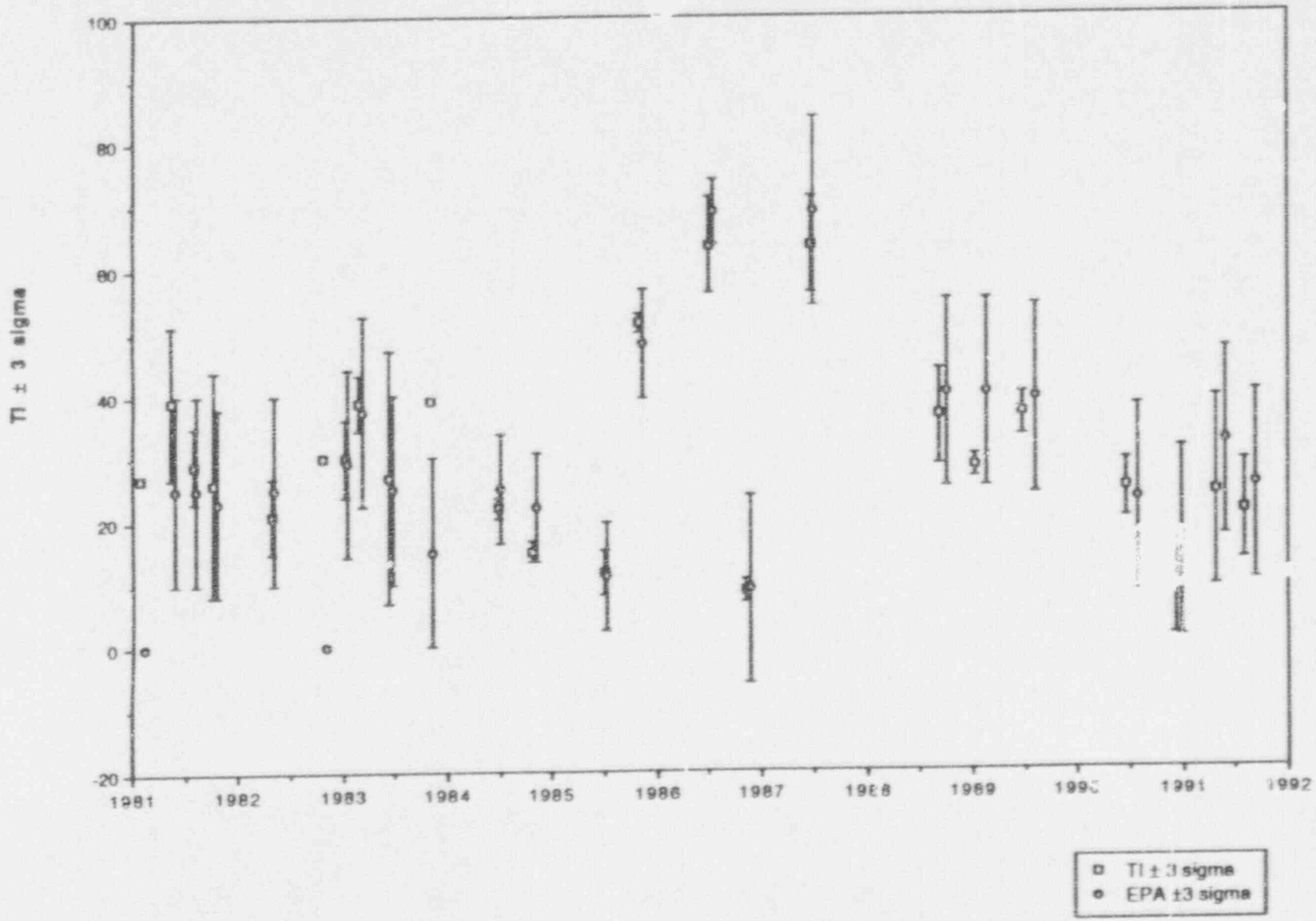
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN MILK



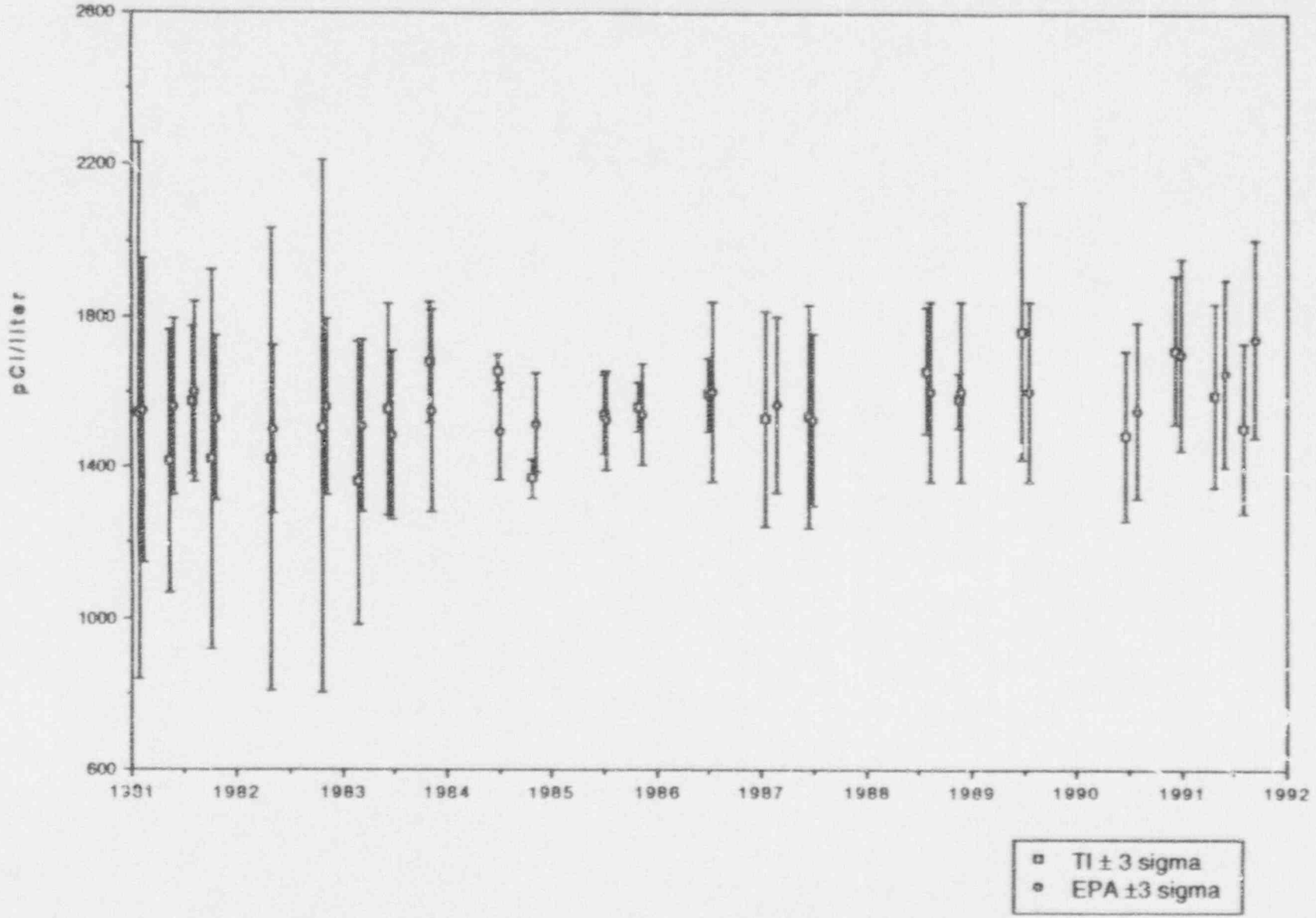
US EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN MILK



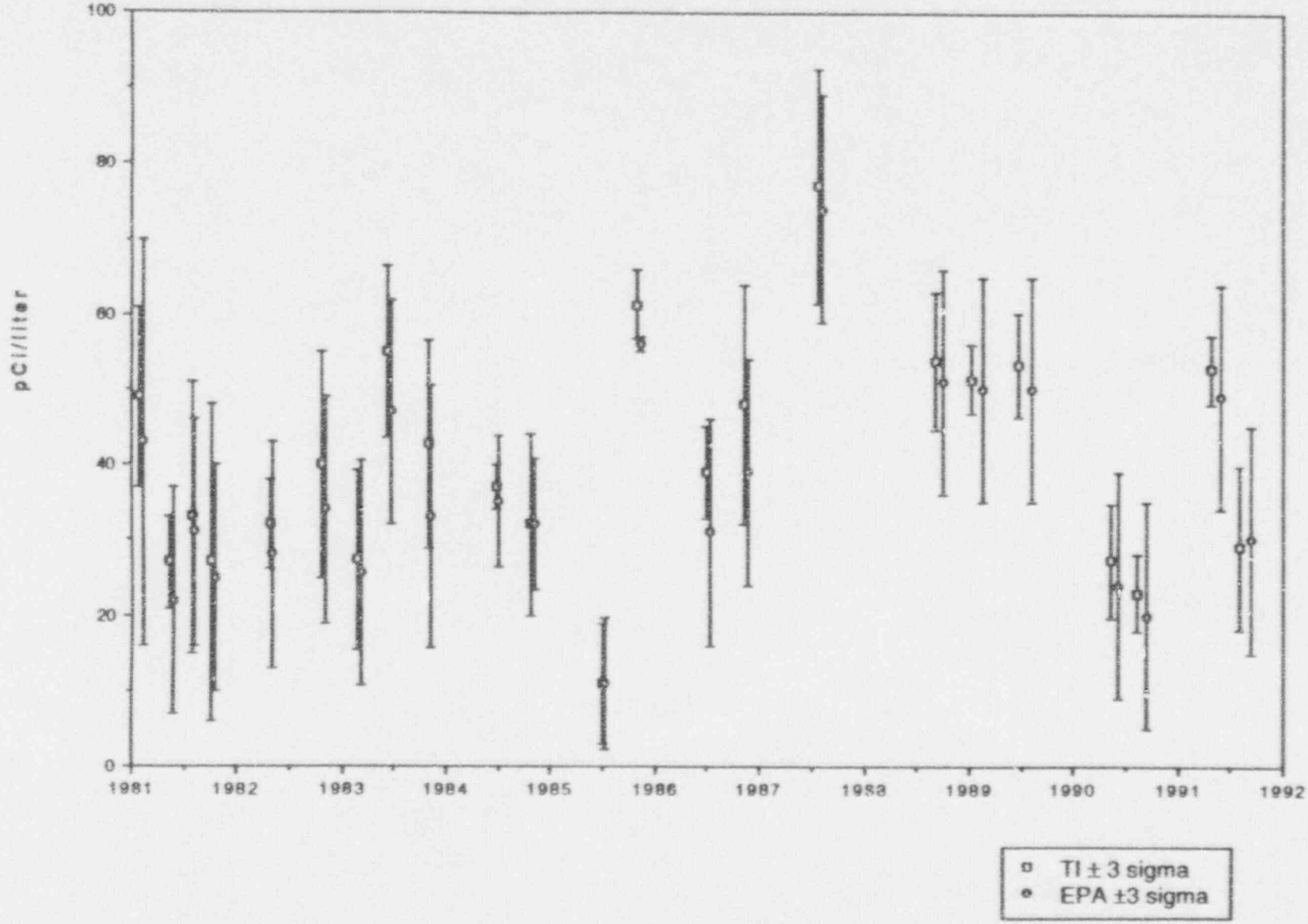
US EPA CROSS CHECK PROGRAM

POTASSIUM-40 IN MILK



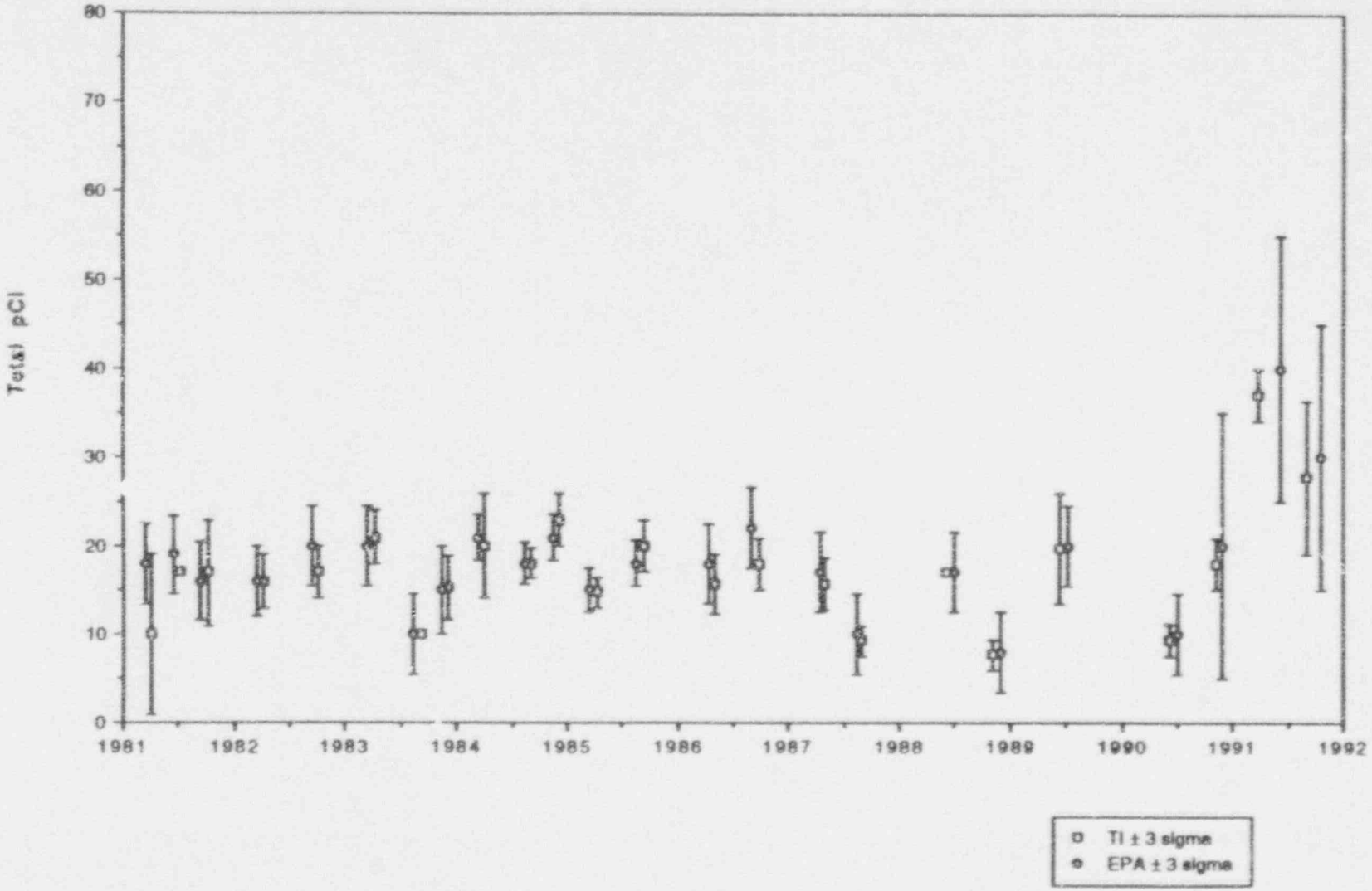
US EPA CROSS CHECK PROGRAM

CESIUM-137 IN MILK



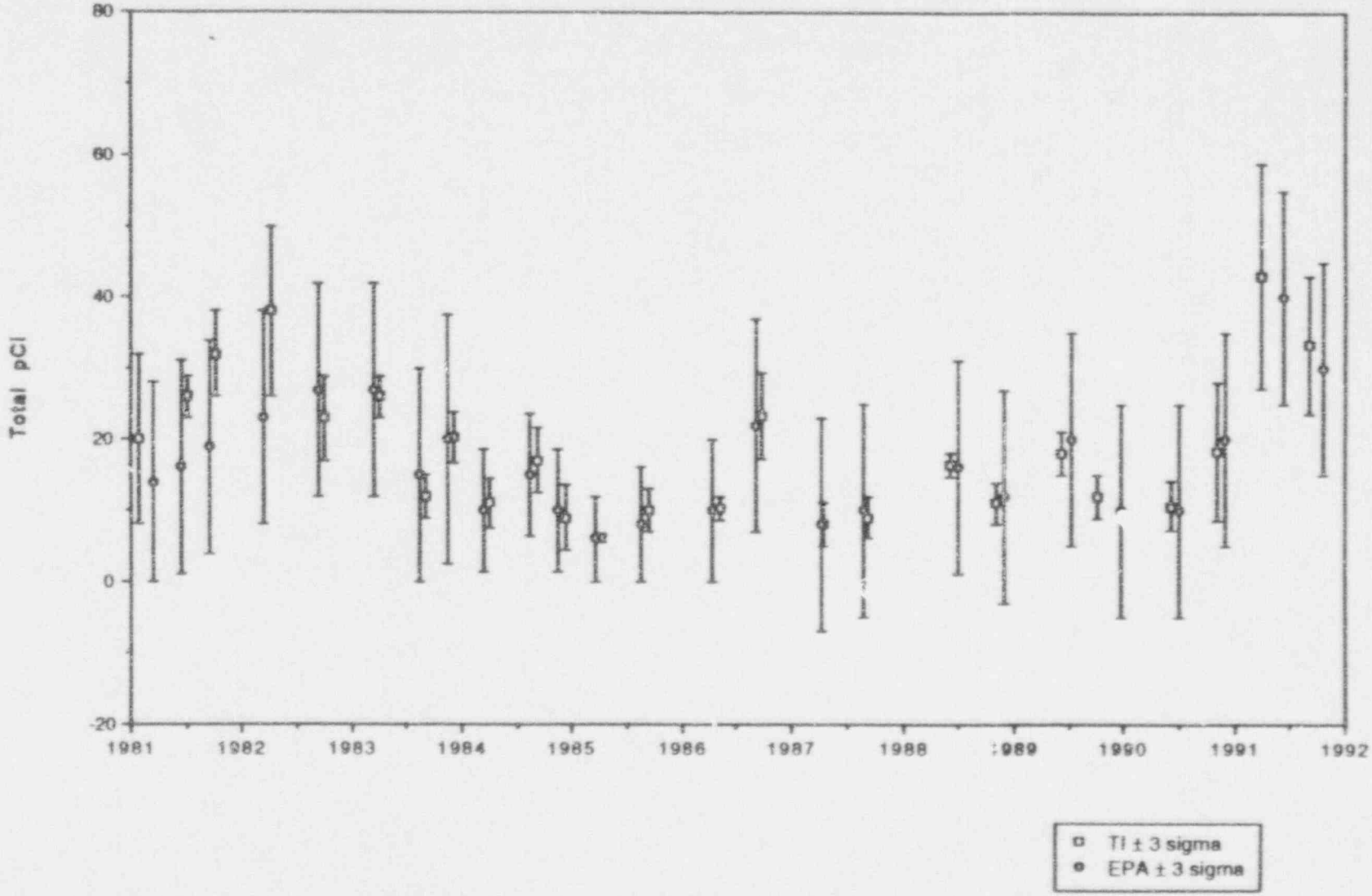
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN AIR PARTICULATES



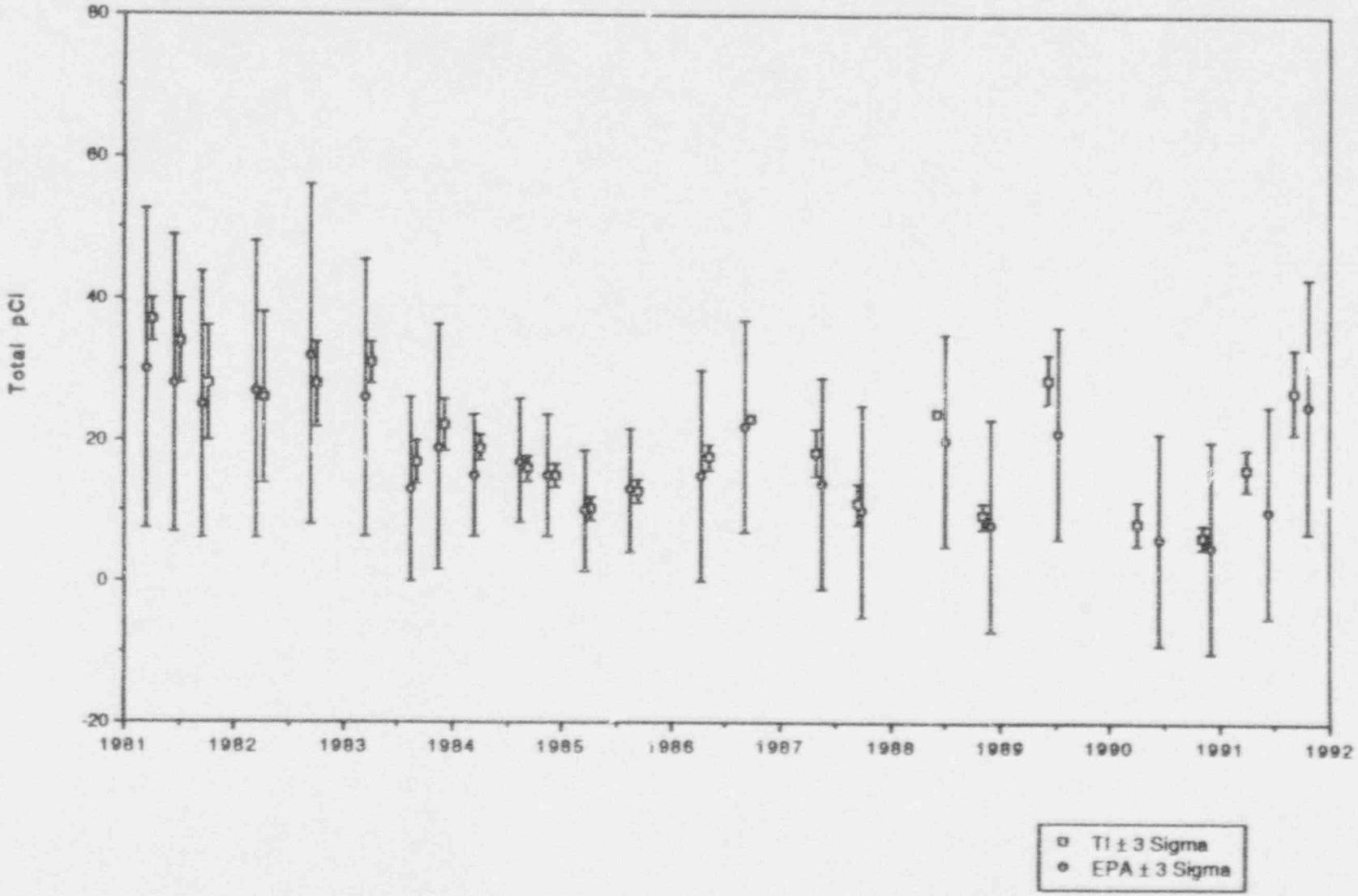
US EPA CROSS CHECK PROGRAM

CESIUM-137 IN AIR PARTICULATES



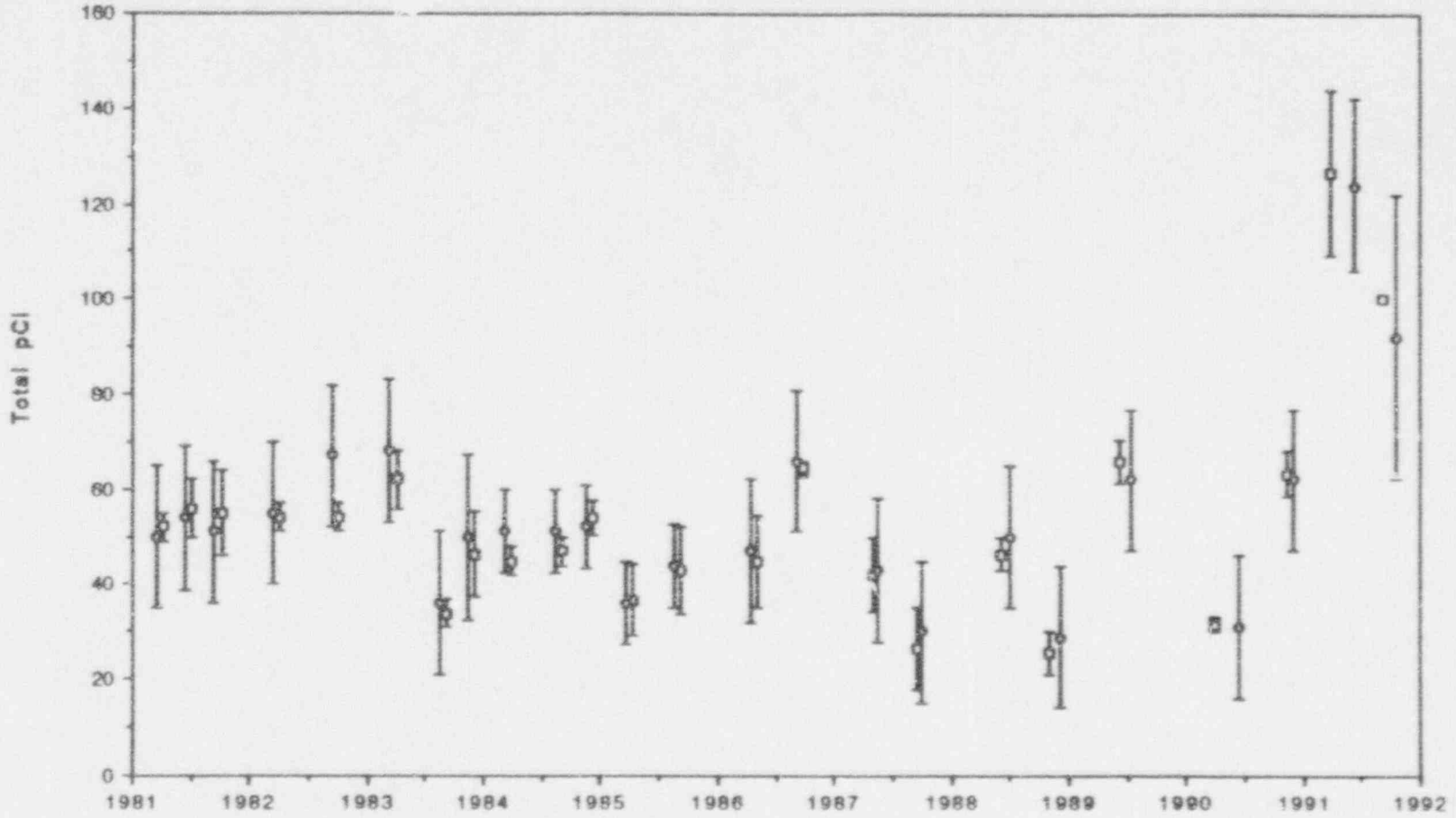
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN AIR PARTICULATES



US EPA CROSS CHECK PROGRAM

GROSS BETA IN AIR PARTICULATES



* 08/25/89 EPA test invalid.

APPENDIX F

REMP SAMPLING AND ANALYTICAL EXCEPTIONS

TABLE F-1

REMP Exceptions for Scheduled
Fish Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
Various	Fish		Samples collected did not meet specified amount; however all required analyses were performed.
14C1	Sea Robin	05/07/91	Collected: 600 g Required: 1.2 kg
13G2	Sea Robin	05/08/91	Collected: 300 g Required: 1.2 kg
3C1	Winter Flounder	10/01/91	Collected: 350 g Required: 1.2 kg
3C1	Windowpane	10/01/91	Collected: 150 g Required: 1.2 kg
3C1	Sea Robin	10/01/91	Collected: 250 g Required: 1.2 kg
14C1	Windowpane	10/02/91	Collected: 100 g Required: 1.2 kg
14C1	Sea Robin	10/02/91	Collected: 250 g Required: 1.2 kg

TABLE F-2

REMP Exceptions for Scheduled
Invertebrate Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
Various	Invertebrates		Samples collected did not meet specified amount; however, all required analyses were performed.
3C1	Lobster	05/06/91	Collected: 800 g Required: 1.2 kg
13G2	Lobster	05/08/91	Collected: 900 g Required: 1.2 kg
3C1	Whelk	05/13/91	Collected: 300 g Required: 1.2 kg
3C1	Lobster	10/01/91	Collected: 800 g Required: 1.2 kg
3C1	Whelk	10/08/91	Collected: 600 g Required: 1.2 kg
13G2	Whelk	10/08/91	Collected: 800 g Required: 1.2 kg

TABLE F-3

REMP Exceptions for Scheduled
Airborne Particulates Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
2A2	Particulate	07/30/91	Pump failure and no sample collected.

TABLE F-4

REMP Exceptions for Scheduled
Milk Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
10F1	Goat Milk	01/01/91- 06/24/91	Goats dired up, supplier did not participate in sampling program.
8F2	Goat Milk	01/10/91- 02/07/91 02/11/91	Goats dired up for kidding.
13B1	Goat Milk	03/07/91	Insufficient sample - low production.

TABLE F-5

REMP Exceptions for Scheduled
Food Products Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
6B21	Strawberries	06/12/91	Unavailable, not locally grown.
12H1	Strawberries	06/12/91	Not locally grown.
8B1	Lettuce, Cabbage, and Peaches	07/24/91 08/08/91	Not locally grown.
12H1	Cabbage, Corn, Carrotts, Potatoes, Tomatoes and Peaches	07/24/91 08/08/91	Not locally grown.
12H2	Lettuce, Cabbage, Carrotts, Tomatoes and Peaches	07/24/91	Not locally grown.
6B21	Lettuce, Cabbage, Corn, Carrotts, Potatoes and Peaches	08/08/91 09/11/91	Not locally grown.
8B1	Cabbage and Peaches	09/11/91	Not locally grown.
12H2	Cabbage, Carrotts, Potatoes and Peaches	09/11/91	Not locally grown.
12H2	Cabbage, Carrotts and Tomatoes	10/23/91	Not locally grown.
12H1	Lettuce	11/14/91	Not locally grown.

TABLE F-6

REMP Exceptions for Scheduled
Potable Water Sampling and Analysis During 1991

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
13S2	Groundwater	03/21/91 06/06/91	Well dry

APPENDIX G

SNPS LAND USE SURVEYS

SNPS LAND USE CENSUS

The Land Use Census program complies with Section 3/4.12.2 of SNPS ODCM. This requires a survey of all milk animals and gardens greater than $50m^2$ (500 ft^2) producing broad leaf vegetation within a radial distance of 8 Km (5 miles). LILCO is also required to identify the nearest milk animal, residence and garden in each of the 16 meteorological sectors.

Environmental Engineering Department conducted the 1991 dairy animal census, during April through July. This survey was conducted by Environmental Technicians driving through each neighborhood within the 5 mile radial distance and visually checking for dairy animals. When a dairy animal was observed the technicians requested information from the owner concerning the amount of milk produced, feed, number of animals and grazing methods.

The 1991 census results indicated that there are no milk producing cows within a 5 mile radial distance from the site; however, the survey did locate the following milk producing goats:

1. Sector 13, 1.9 miles west of SNPS
   Poole
   Briarcliff Road
   Shoreham, New York 11786

   REMP Monitoring Location 13B1

   Inventory: 1 milking goat
   1 non-milking goat

   Inventory Date: April 18, 1991

2. Sector 11, 2.40 miles southwest of SNPS
   Shoreham-Wading River School District
   Middle School
   Randall Road
   Shoreham, New York 11786

   REMP Monitoring Location 11C1 (Milk not being sampled due to owners decision not to participate).

   Inventory: 2 milking goats
   0 non-milking goat

   Inventory Date: April 18, 1991

Table G-1 lists the nearest milk animal in the sixteen meteorological sectors. Additional field survey data are filed in the Shoreham Record Retrieval System.

The Garden Census was also conducted by Environmental Engineering Technicians visually noting each garden of $50m^2$ ($500\ ft^2$) or greater. The 1991 census was performed during July, August, and September locating a total of 206 gardens. Table G-2 lists the nearest garden in the sixteen meteorological sectors. The field survey sheets and maps are filed at Environmental Engineering Melville and in the Shoreham Record Retrieval System.

Environmental Engineering identifies nearest residences by utilizing both aerial photography and visual confirmation. This year's census was conducted in November and December. Table G-3 lists the nearest residence in each meteorological sector.

TABLE G-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
1991 Land Use Census
Nearest Milk Animal (within 8 km)*

Sector	Direction	Location
1	N	Area within sector is Long Island Sound
2	NNE	None
3	NE	None
4	ENE	None
5	E	None
6	ESE	None
7	SE	None
8	SSE	None
9	S	None
10	SSW	None
11	SW	Shoreham - Wading River Middle School Randall Road, Shoreham
12	WSW	None
13	W	C.B. Poole residence, Briarcliff Road, Shoreham
14	WNW	None
15	NW	Area within sector is Long Island Sound
16	NNW	Area within sector is Long Island Sound

* SNPS ODCM Part I, Section 3/4.12.2

TABLE G-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

1991 Land Use Census

Nearest Garden (> 50m^2 within 8 km)*

Sector	Garden Code #	Location & Direction
1	-	Area within sector is Long Island Sound
2	-	None
3	-	None
4	4B22G	Czebotar, Sunset Blvd., Wading River, 5853' ENE of SNPS.
5	5A11G	Loggia, Little Bay Road, Wading River, 3978' E. of SNPS.
6	6A12G	Punda, Sound Ave., Wading River, 4343' ESE of SNPS.
7	7814G	Waski, Gateway Dr., Wading River, 6788' SE of SNPS.
8	8A14 (8B1)	Pierzchanowski, Randall Road, Wading River, 5191' SSE of SNPS.
9	9B14	Smith, Randall Road, Wading River, 6027' S of SNPS.
10	10C13G	Waligura, Bradley Dr., Shoreham, 14,014' SSW of SNPS.
11	11B31	Marcott, Jomarr Road, Shoreham 7246', SW of SNPS.
12	12B31	Murtagh, Harvard Road, Shoreham, 6401' SW of SNPS.
13	13B22	Connoly, Valentine Road, Shoreham, 4893' W of SNPS.
14	-	None
15	-	Area within sector is Long Island Sound
16	-	Area within sector is Long Island Sound

* SNPS ODCM Part I, Section 3/4.12.2

TABLE G-3

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

1991 Land Use Census

Nearest Residence (within 8 km)*

Sector	Direction	Location
1	N	Area within sector is Long Island Sound
2	NNE	Thurber-Creek Road, Wading River, 1503' from SNPS
3	NE	Creek Road, Wading River, 1916' from SNPS (First house east of Field and Tennis Club).
4	ENE	Hughes-Creek Road, Wading River, 3444' from SNPS (fifth house west of Riverhead Town Beach)
5	E	Peterson-Sound Road, Wading River, 3598' from SNPS
6	ESE	Bartow-Sound Road, Wading River, 2917' from SNPS
7	SE	Larsen-North Country Road and Thomas Drive, Wading River, 3304' from SNPS
8	SSE	North Country Road, fifth house west of Pheasant Run, Wading River, 2588' from SNPS
9	S	Fugelsang- 20 Long Bow, Wading River, 3839' from SNPS
10	SSW	16 Defense Hill Road, Wading River, 4877' from SNPS
11	SW	170 North Country Road, Wading River, 1632' from SNPS
12	WSW	Gildea-Valentine Road, Shoreham, 5557' from SNPS
13	W	Brice, 55 Valentine Road, Shoreham, 4620' from SNPS

* SNPS ODCM Part I, Section 3/4.12.2

TABLE G-3 (Cont.)

Sector	Direction	Location
14	WNW	St. Joseph's Villa, Wading River, 2178' from SNPS
15	NW	Area within sector is Long Island Sound
16	NNW	Area within sector is Long Island Sound

APPENDIX H

COMMON AND SCIENTIFIC NAMES OF SPECIES COLLECTED IN THE REMP

TABLE H-1

COMMON AND SCIENTIFIC NAMES OF SPECIES COLLECTED
IN THE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Common Name	Scientific Name
Fish	
Winter Flounder	Pseudopleuronectes americanus
Windowpane	Scophthalmus aquosus
Searobin	Prionotus spp.
Little Skate	Raja erinacea
Fluke	Paralichthys dentatus
Bluefish	Pomatomus saltatrix
Invertebrates	
American Lobster	Homarus americanus
Squid	Loligo pealeii
Channeled Whelk	Busycon canaliculata