



HAZLETON

ENVIRONMENTAL SCIENCES CORPORATION

500 FRONTAGE ROAD, NORTHBROOK, ILLINOIS 60062, U.S.A.

REPORT TO

TOLEDO EDISON COMPANY
TOLEDO, OHIO

OPERATIONAL
ENVIRONMENTAL RADIOLOGICAL MONITORING
FOR THE
DAVIS-BESSE NUCLEAR POWER STATION
OAK HARBOR, OHIO

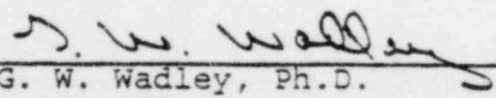
ANNUAL REPORT
SUMMARY AND INTERPRETATION
JANUARY - DECEMBER 1978

FOR SUBMITTAL TO THE NUCLEAR
REGULATORY COMMISSION

PREPARED AND SUBMITTED
BY
HAZLETON ENVIRONMENTAL SCIENCES CORPORATION

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PREFACE

The staff of the Nuclear Sciences of Hazleton Environmental Sciences Corporation (HESC) were responsible for the acquisition of the data presented in this report. Samples were collected by members of the staff of the Davis-Besse Nuclear Power Station and by local sample collectors.

The report was prepared by L. G. Huebner, Director, Nuclear Sciences. He was assisted in the report preparation by the following staff members: S. J. Bartman, C. A. Johnson, C. R. Marucut, L. A. Nicia, and Dr. R. E. Wild.

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I. Introduction

Because of the many potential pathways of radiation exposure to man from both natural and man-made sources, it is necessary to document levels of radioactivity and the variability of these levels which exist in an area prior to the anticipated release of any additional radioactive nuclides. To meet this objective, an extensive preoperational environmental radiological monitoring program was initiated for the Toledo Edison Company in the vicinity of the Davis-Besse Nuclear Power Station site. This program included collection (both onsite and offsite) and radiometric analyses of airborne particulates, airborne iodine, ambient gamma radiation, milk, groundwater, meat and wildlife, fruits and vegetables, animal and wildlife feed, soil, surface water, fish, and bottom sediments. BIO-TEST/NALCO ES completed the first four-and-one-half years of preoperational monitoring in December of 1976 and one year of preoperational and operational monitoring in December of 1977.

Fuel elements were loaded in Unit 1 on 23 through 27 April 1977 and the initial criticality was achieved on 12 August 1977. Unit 1 achieved one hundred percent of its operational capacity on 4 April 1978.

This report, prepared by Hazleton Environmental Sciences (HES), presents one full year of operational data for the environmental radiological monitoring at the Davis-Besse Nuclear Power Station.

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II. Summary

Results of sample analyses during the period January - December 1978 are summarized in Table 5. Tabulations of data for all samples collected during this period, additional statistical analyses of the data, and graphs of data trends are presented in a separate report to the Toledo Edison Company.

Monitoring data collected during the period January - December 1978 were similar to data obtained during 1977, but slightly higher than in 1976. The major contributor to these elevated levels was residual fallout from the atmospheric detonation of a 20 kiloton device detonated on 17 September 1977 and of a less than 20 kiloton device detonated on 14 March 1978.

None of the results indicate any effect on the radiological environment due to the operation of Davis-Besse Nuclear Station, Unit 1.

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III. Methodology

The sampling locations for the Preoperational Environmental Radiological Monitoring Program at the Davis-Besse Nuclear Power Station are shown in Figures 1 and 2. Table 1 describes the locations, lists for each its direction and distance from the station, and indicates which are indicator and which are control locations.

The sampling program monitors the air, terrestrial, and aquatic environments. The types of samples collected at each location and the frequency of collections are presented in Table 2 using codes defined in Table 3. Below, the collections and analyses that comprise the program are described. Finally, the execution of the program in the current reporting annual period (January - December 1978) is discussed.

A. Program Modification

During the reporting period the monitoring program was modified slightly to include annual collection and analyses of soil samples. Details are given in Section III.C.7.

B. The Air Program

1. Airborne Particulates

The airborne particulate samples are collected on 47 mm diameter membrane filters of 0.8 micron porosity at a volumetric rate of approximately one cubic foot per minute. The filters are collected weekly from eleven locations (T-1, T-2, T-3, T-4, T-7, T-8, T-9, T-11, T-12, T-23, and T-27), placed in

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individual glassine protective envelopes, and dispatched by mail to HES for radiometric analyses. The filters are analyzed for gross beta activity approximately five days after collection to allow for decay of naturally-occurring short-lived radionuclides. The quarterly composites of all air particulate samples from indicator locations (T-1, T-2, T-3, T-4, T-7, and T-8) and of all air particulate samples from control locations (T-9, T-11, T-12, T-23, and T-27) are gamma-scanned and analyzed for strontium-89 and -90.

2. Airborne Iodine

Each air sampler is equipped with a charcoal trap in-line after the filter holder. The charcoal trap at each location is changed at the same time as the particulate filter and analyzed for iodine-131 immediately after arrival at the laboratory.

3. Ambient Gamma Radiation

The integrated gamma-ray background from natural radiation is measured with thermoluminescent dosimeters (TLD). Monthly and quarterly TLD's are placed at thirteen locations (the eleven air sampling locations and locations T-5 and T-24).

Each shipment of TLD's includes controls which are stored in a shield at the station and returned with the field TLD's after their removal. In-transit exposures are measured by the control TLD's and subtracted from the field TLD measurements to obtain their net exposure.

C. The Terrestrial Program

1. Milk

Two-gallon milk samples are collected semi-monthly

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during the grazing period (May through October) and monthly during the rest of the year from two indicator locations (T-8 and T-20) and one control location (T-24). The milk samples are analyzed for iodine-131, strontium-89 and -90, calcium, stable potassium, and are gamma-scanned.

2. Groundwater

One-gallon well water samples are collected quarterly from two indicator locations (T-7 and T-17) and from one control location (T-27). The gross beta activity is determined on the suspended and dissolved solids of each sample. The samples are also gamma scanned and analyzed for strontium-89 and -90, and tritium.

3. Edible Meat

Semi-annually, domestic meat samples (chickens) are collected from one indicator location (T-32) and one control location (T-34) and one representative species of wildlife (muskrat or raccoon) is collected onsite (T-31). In addition, one waterfowl species and one snapping turtle are collected annually onsite (T-31) or in the site vicinity (T-33). Gamma-spectroscopic analysis is performed on the edible portions of each sample.

4. Fruits and Vegetables

Semi-annually, two varieties of fruits and vegetables are collected from each of the two indicator locations (T-8 and T-25) and from one control location (T-34). The edible portions are gamma scanned and analyzed for strontium-89 and -90.

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5. Green Leafy Vegetables

Monthly, during the harvest season, green leafy vegetables are collected from one indicator location (T-36) and one control location (T-37). The samples are analyzed for iodine-131. Should green leafy vegetables from private gardens not be available, nonedible plants with similar leaf characteristics from the same vicinity may be substituted.

6. Animal-Wildlife Feed

Animal feed is collected semi-annually from one indicator location (T-8) and one control location (T-34). Cattle-feed is collected during the first quarter and grass is collected during the third quarter. Also, once a year, a sample of smartweed is collected from location T-31 (onsite). Gamma-spectroscopic analysis is performed on all samples.

7. Soil

Once a year, soil samples are collected from all eleven air sampling locations; six indicator locations (T-1, T-2, T-3, T-4, T-7, and T-8) and five control locations (T-9, T-11, T-12, T-23, and T-27). Gamma-spectroscopic analysis is performed on all samples.

D. The Aquatic Program

1. Treated Surface Water

Weekly grab samples of treated water are collected at one indicator location (T-28, Unit 1 treated water supply, on-site) and two control locations (T-11 and T-12, Port Clinton and Toledo filtration plants). The samples from each location are

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composited monthly and analyzed for gross beta activity in dissolved and suspended solids. Quarterly composites from each location are gamma scanned and analyzed for strontium-89 and -90, and tritium.

2. Untreated Surface Water

Weekly grab samples of untreated water from Lake Erie are collected from one indicator location (T-3) and from two control locations (T-11 and T-12, Port Clinton and Toledo filtration plants, untreated water tap). In addition, hourly grab samples are collected from one in-plant water supply (T-28, Unit 1 untreated water supply, onsite). The samples from each location are composited monthly and analyzed for gross beta activity in dissolved and suspended solids. Quarterly composites from each location are gamma scanned and analyzed for strontium-89 and -90, and tritium.

3. Fish

Two species of fish are collected semi-annually from each of two locations in Lake Erie; from one indicator location in the vicinity of the discharge (T-33) and one control location approximately 15 miles from the plant (T-34; Put-In-Bay area). The flesh is separated from the bones and analyzed for gross beta and gamma-emitting isotopes.

4. Bottom Sediments

Semi-annually, bottom sediments are collected from three locations in Lake Erie; at two indicator locations, intake (T-29) and discharge (T-30), and at one control location about 5.3

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miles WNW from the plant (T-27). The samples are gamma scanned and analyzed for gross beta and strontium-89 and -90.

E. Program Execution

Program execution is summarized in Table 4. The program was executed as described in the preceding sections with the following exceptions:

(1) There were no air particulate or I-131 data from location T-3 for the week of 1-23-78 to 2-02-78; from location T-4 for the weeks of 3-20-78 to 3-37-78 and 4-17-78 to 4-24-78; from location T-8 for the week of 8-28-78 to 9-05-78; from location T-12 for the week of 9-25-78 to 10-02-78; and from location T-27 for the weeks of 1-09-78 to 1-17-78, 1-17-78 to 1-23-78, 1-23-78 to 1-31-78, 10-09-78 to 10-16-78, and 11-27-78 to 12-04-78 because the pumps failed.

(2) There were no air particulate or I-131 data from location T-27 for the week of 1-31-78 to 2-06-78 because of the power failure and timer malfunction.

(3) Well water sample was not collected from location T-7 in January of 1978 because water line was frozen.

(4) Snapping turtle was collected from location T-31 because it was not available at location T-33.

(5) Weekly samples of untreated surface water were not collected from Lake Erie (T-3) during the months of January, February, and March of 1978 because the lake was frozen.

(6) There was no iodine-131 datum from location T-9 for the week of 2-13-78 to 2-21-78 because the sample was not sent to the laboratory due to oversight.

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IV. Results and Discussion

The results for the reporting period January to December 1978 are presented in summary form in Table 5. For each type of analysis of each sampled medium, this table shows the annual mean and range for all indicator locations and for all control locations. The location with the highest annual mean and the results for this location are also given.

The discussion of the results has been divided into three broad categories; the air, terrestrial, and aquatic environments. Within each category, samples are discussed in the order listed in Table 4. Any references to previous environmental data for the Davis-Besse Nuclear Power Station refer to data collected by Hazleton Environmental Sciences/NALCO Environmental Sciences, or Industrial BIO-TEST Laboratories, Inc.

The tabulated results of all measurements made during 1978 are not included in this section, although references to these results are made in the discussion. The complete tabulation of the results is submitted to the Toledo Edison Company in a separate report.

A. Effects of Chinese Atmospheric Nuclear Detonations

Two atmospheric nuclear detonations by the People's Republic of China had some impact on program results in 1978. The first of the detonations occurred on 17 September 1977 and had some residual effect on the results. The second detonation conducted on 14 March 1978 had a more pronounced effect on the results, especially on air particulates data. A third detonation conducted by China

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on 14 December 1978 produced no noticeable effects.

This section briefly reviews information about the tests and the environmental effects as reported by the EPA (U. S. Environmental Protection Agency, 1978).

The 17 September 1977 test had an estimated yield of 20 kilotons and injected radioactive debris into the upper troposphere (30,000 to 40,000 feet). The leading edge of the contaminated air mass passed over the western edge of the continental United States on 21 September 1977 and probably reached Michigan two days later. It caused elevated gross beta activities in air particulates and elevated levels of iodine-131 in milk in nearly all parts of the United States.

The 14 March 1978 test had an estimated yield of less than 20 kilotons. The National Oceanic and Atmospheric Administration predicted that the fallout cloud would reach the United States on March 18. EPA gross beta results for air particulates indicated that the main body of the cloud had reached the central United States by 23 March 1978. Elevated levels of iodine-131 in milk were also detected throughout the United States.

The 14 December 1978 test had an estimated yield of less than 20 kilotons. Results of measurements made by the EPA in response to this test are not yet available. Data collected by Hazleton at seven sites in the North Central United States has not shown any elevated results attributable to fallout from this test.

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B. Census of Milch Animals

In compliance with the Environmental Technical Specifications for the Davis-Besse Nuclear Power Station, the annual census of milch animals was conducted on 25 May 1978 by plant personnel. There were no known goats within a 15 mile radius of the station. Cow herds counted were: Moore Farm, 2.7 miles WSW of the station, 40 cows; Daup Farm, 5.4 miles SSE of the station, 25 cows; and Gaetes Farm, 5.5 miles WSW of the station, 30 cows. The Moore and Daup farms are indicator location T-8 and control location T-20, respectively.

C. The Air Environment

1. Airborne Particulates

Gross beta measurements yielded annual means that were nearly identical at the five control locations (0.095 pCi/m^3) and at the six indicator locations (0.096 pCi/m^3). The location with the highest annual mean (0.108 pCi/m^3) was control location T-9 at Oak Harbor, 6.8 miles SW of the station.

Gross beta activities at all locations were also statistically analyzed by months and quarters. The highest averages were for the month of March and the first and second quarters. The March peak in gross beta activity was due to fallout from the 14 March 1978 weapons test. Activity due to fallout prevented observation of the normal spring peak in gross beta activity, which has been observed almost annually (1976 was an exception) for many years (Wilson et. al., 1969) and has been attributed to fallout of nuclides from the stratosphere (Gold et. al., 1964).

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Strontium-90 annual mean activity was identical for indicator and control locations. Strontium-89 mean annual activity was somewhat higher for indicator locations (0.00251 pCi/m^3) than for control locations (0.00169 pCi/m^3). The highest strontium-89 and -90 activity was measured during the second quarter, and was due to the Chinese nuclear test conducted on 14 March 1978.

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded nearly identical results for indicator and control locations. The predominant gamma-emitting isotope was beryllium-7 which is produced continuously in the upper atmosphere by cosmic radiation (Arnold and Al-Salih, 1955). Trace amounts of zirconium-95, niobium-95, ruthenium-103, ruthenium-106, cesium-137, and cerium-144 were also detected in some samples. Activities of these isotopes reached their highest levels during the first and second quarter and then decreased for the remainder of the year. The higher activity of fission products was attributable to the spring nuclear test. There was no indication of a station effect on the data.

2. Airborne Iodine

Weekly levels of airborne iodine-131 were equal to or below the lower limit of detection (LLD) of 0.02 pCi/m^3 throughout 1978. Only ten of 536 samples yielded detectable results ranging from $0.02 \pm 0.01 \text{ pCi/m}^3$ to $0.04 \pm 0.01 \text{ pCi/m}^3$. The activity was detected approximately two weeks after the Chinese nuclear test conducted on 14 March 1978.

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3. Ambient Gamma Radiation

Monthly TLD's at the indicator locations measured a mean equivalent dose of 15.6 mrem/91 days at indicator locations and a mean of 17.7 mrem/91 days at control locations. These results were in agreement with the values obtained by quarterly TLD's. The highest annual means for monthly TLD's (19.9 mrem/91 days) and for quarterly TLD's (20.4 mrem/91 days) occurred at control location T-24. The annual mean dose equivalent for all locations measured by monthly and quarterly TLD's was 16.3 mrem/91 days, and was similar to the dose measured in 1977 (16.8 mrem/91 days). This is slightly lower than the average natural background radiation for Middle America, 19.5 mrad/quarter.¹

D. The Terrestrial Environment

1. Milk

A total of 54 analyses for iodine-131 in milk were performed during the reporting period. All samples except one contained less than 0.5 pCi/l of iodine-131. The single exception was the milk sample collected on 11 April 1978 from the Daup Farm (T-20), 5.4 miles SSE of the station. The analysis yielded 0.8 ± 0.2 pCi/l of iodine-131. The detected activity is attributable to the Chinese weapons test conducted on 14 March 1978.

¹ This estimate is based on data on pp. 71 and 108 of the report Natural Background Radiation in the United States (National Council on Radiation Protection and Measurements, 1975). The terrestrial absorbed dose (uncorrected for structural and body shielding) ranges from 35 to 75 mrad/y and averages 46 mrad/y for Middle America. Cosmic radiation and cosmogenic radionuclides contribute 32 mrad/y for an average of 78 mrad/y or 19.5 mrad/quarter.

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Strontium-89 was detected in one of 54 milk samples. The value of 5.5 pCi/l was detected in the milk sample collected on 6 February 1978 from control location T-24 (Toft's Dairy, 24.9 miles SE of the station). The detected strontium-89 activity was attributable to the Chinese nuclear tests conducted in the fall of 1977.

Strontium-90 activity was detected in 51 of 54 samples analyzed and ranged from 0.6 to 3.2 pCi/l. The ranges were similar at both control and indicator locations. The annual mean value for strontium-90 was slightly higher at the indicator locations (2.0 pCi/l) than at the control locations (1.81 pCi/l). The location with the highest mean (2.2 pCi/l) was control location T-24. The mean values were similar to those measured in 1977.

The activities of Ba-140 were below the LLD for all samples collected.

Results for cesium-137 and potassium-40 were nearly identical at control and indicator locations (4.2-4.5 pCi/l and 1340 - 1390 pCi/l for cesium-137 and potassium-40, respectively). Indicator location T-8 had the highest mean (4.5 pCi/l) for cesium-137 and for potassium-40 (1390 pCi/l).

Since the chemistries of calcium and strontium, and potassium and cesium are similar, organisms tend to deposit cesium-137 in muscle and soft tissue and strontium-89 and -90 in bones. In order to detect potential environmental accumulation of these radionuclides, the ratios of the strontium-90 activity to the weight of calcium and of the cesium-137 activity to weight of stable potassium were monitored in milk. The measured concentrations of calcium and stable potassium were in agreement with previously

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determined values of 1.16 ± 0.08 g/l and 1.50 ± 0.21 g/l, respectively (National Center for Radiological Health, 1968). No statistically significant variations in the ratios were observed.

2. Groundwater (Well Water)

Gross beta activities in suspended solids were below the LLD of 0.3 pCi/l for all samples. Gross beta activities in dissolved solids averaged 4.1 pCi/l at the indicator locations and 2.8 pCi/l at the control location. The location with the highest annual mean was the indicator location T-7 and averaged 4.4 pCi/l.

Four of eleven samples contained more than the LLD of 180 pCi/l of tritium. An activity of 320 pCi/l was detected at indicator location T-7. The mean value for all locations was 240 pCi/l.

Strontium-89 activity was below the LLD of 2.0 pCi/l for all samples. There was one detectable strontium-90 activity, 1.5 pCi/l, collected at indicator location T-7.

All samples were below the LLD of 3.7 pCi/l for cesium-137 activity.

The activities detected in well water were not significant when compared with the LLD and were not attributable to the station operation.

3. Edible Meat

In edible meat samples (chicken, raccoon, goose, and snapping turtle) the mean potassium-40 activity was 1.9 pCi/g

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wet weight for the indicator locations and 2.0 pCi/g wet weight for the control location. The difference was not statistically significant. All cesium-137 activities were below the LLD (0.02 pCi/g wet weight).

4. Fruits and Vegetables

Strontium-89 activity was below the LLD of 0.0083 pCi/gm wet weight for all samples.

Strontium-90 activities averaged 0.0125 pCi/g wet weight at the indicator locations and 0.0180 pCi/g wet weight at the control location. All samples were collected in mid-July and early October. The strontium-90 activity detected was attributable to fallout from previous nuclear tests.

The only gamma-emitting isotope detected was potassium-40. The mean activities were 2.1 pCi/g wet weight for indicator locations and 2.0 pCi/g wet weight for the control locations. The activity detected was similar to that detected in 1977. All other gamma-emitting isotopes were below their respective LLD's.

5. Green Leafy Vegetables

Green leafy vegetables (cabbage, cauliflower leaves, lettuce, and celery) collected during harvest season were analyzed for iodine-131. All results were below the LLD of 0.01 pCi/g wet weight. All gamma-emitting isotopes, except potassium-40, were below their respective LLD's. Potassium-40 activity averaged 3.0 pCi/g wet weight and 2.3 pCi/g wet weight for indicator and control locations, respectively.

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6. Animal-Wildlife Feed

In grass, smartweed, and silage the predominant gamma-emitting isotope was potassium-40. The annual mean for control location T-34 was higher (9.7 pCi/g wet weight) than the mean value for indicator locations (5.0 pCi/g wet weight).

The cesium-137 level was 0.11 pCi/g wet weight in smartweed collected at indicator location T-31 and 0.05 pCi/g wet weight in grass collected at control location T-34. All other gamma-emitting isotopes were below their respective LLD's.

7. Soil

Soil samples were collected in June of 1978 and analyzed for gamma-emitting isotopes. The predominant activity was potassium-40 which had a mean of 19.7 pCi/g dry weight at indicator locations and of 25.4 pCi/g dry weight at control locations. Cesium-137 was detected in seven of eight samples and cerium-144 was detected in one of eight samples analyzed. The mean activities of these isotopes ranged from 0.089 to 3.439 pCi/g dry weight. With the exception of cerium-144, which was detected at only one indicator location, the mean activities were higher at control locations (1.094 pCi/g versus 0.599 pCi/g dry weight). The highest cesium-137 activity, 3.439 pCi/g, was detected at the control location T-23, 14.3 miles SE of station. All other gamma-emitting isotopes were undetectable.

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E. The Aquatic Environment

1. Water Samples - Treated

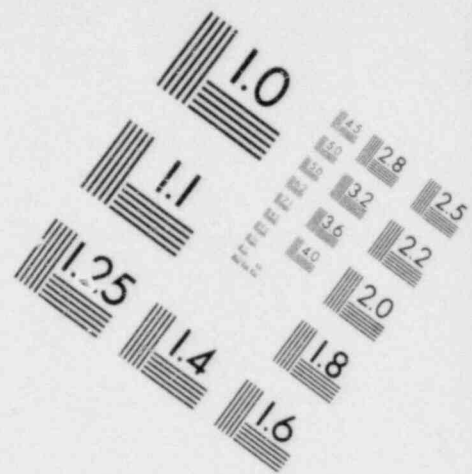
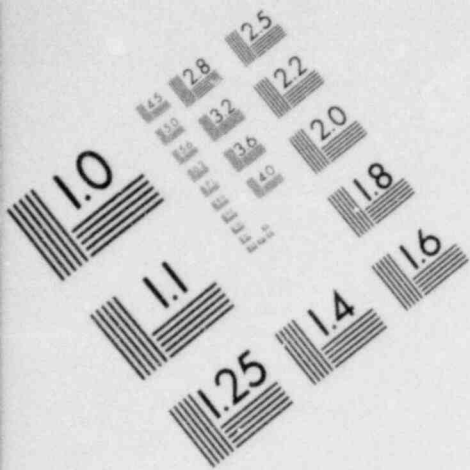
In treated water samples the gross beta activity in suspended solids was below the LLD of 0.4 pCi/l at all locations. Gross beta activity in dissolved solids averaged 2.9 pCi/l at indicator locations and 3.2 pCi/l at control locations. The values are similar to those measured in 1975, 1976 and 1977. Annual mean tritium activity was identical at both indicator and control locations.

Strontium-89 and strontium-90 activities were below their respective LLD's of 2.0 pCi/l and 0.9 pCi/l. Cesium-137 activity was below the LLD of 3.7 pCi/l.

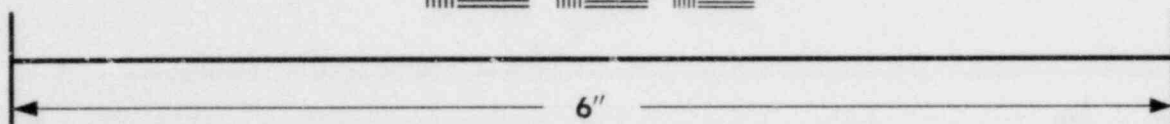
2. Water Samples - Untreated

In untreated water samples the mean gross beta activity in suspended solids was 2.5 pCi/l at indicator locations and 2.1 pCi/l at control locations. In dissolved solids the mean activity was 4.2 pCi/l at both indicator and control locations. For total residue the mean activities were 6.4 pCi/l at indicator locations and 5.4 pCi/l at control locations. None of these results show statistically significant differences between indicator and control locations.

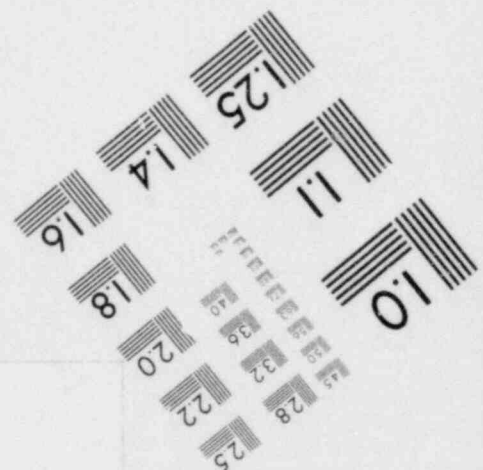
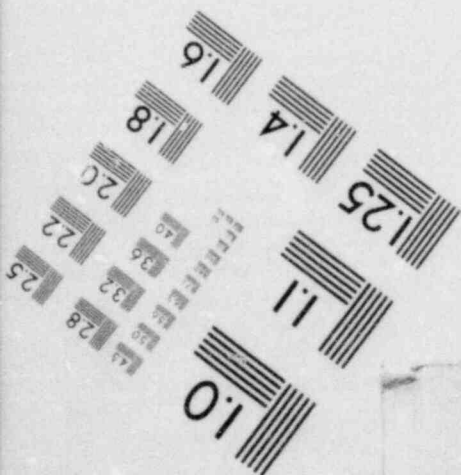
The mean tritium activity for indicator and control locations were nearly identical (310 pCi/l and 320 pCi/l, respectively). These results were in agreement with those obtained for treated water.

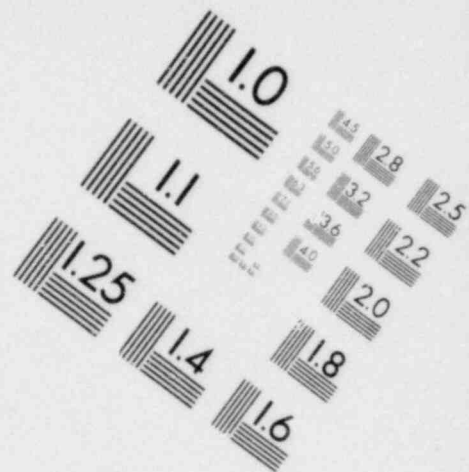
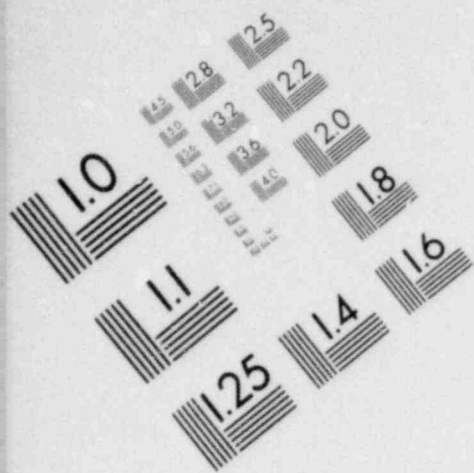


**IMAGE EVALUATION
TEST TARGET (MT-3)**

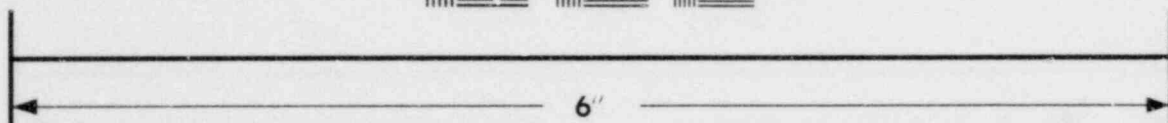
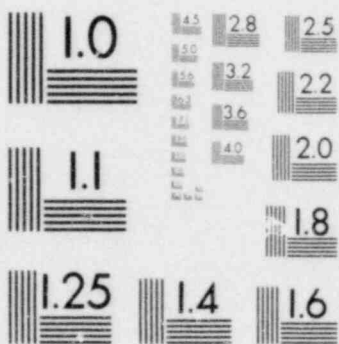


MICROCOPY RESOLUTION TEST CHART

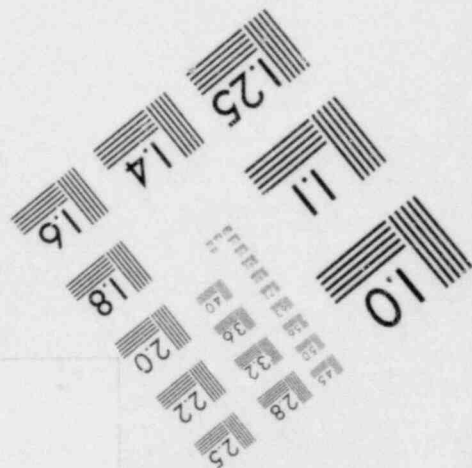
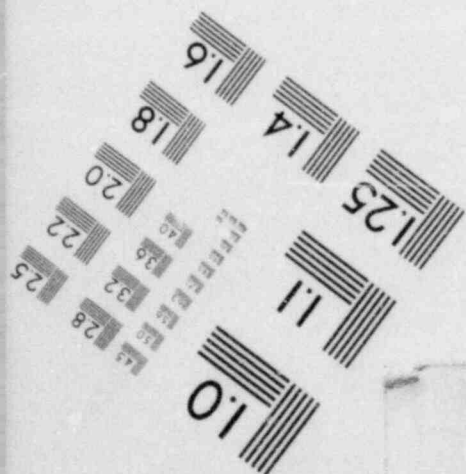




**IMAGE EVALUATION
TEST TARGET (MT-3)**



MICROCOPY RESOLUTION TEST CHART



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Strontium-89 was below the LLD of 2.0 pCi/l for all samples, while strontium-90 was above the LLD of 0.9 pCi/l in four of fifteen samples. The mean strontium-90 activity was 1.0 pCi/l for indicator locations and 1.1 pCi/l for control locations. The measured values were similar to those obtained in 1977 and were not significantly different between indicator and control locations.

Cesium-137 activity was below the LLD of 3.7 pCi/l for all locations.

3. Fish

The mean gross beta activity in fish muscle was 2.46 pCi/g wet weight for indicator locations and 2.15 pCi/g wet weight for control locations.

Potassium-40 and cesium-137 were the only gamma-emitting isotopes detected. The mean potassium-40 activity was 2.2 pCi/g wet weight for the indicator location and 2.1 pCi/g wet weight for the control location. The mean cesium-137 activity was 0.027 pCi/g wet weight for the indicator location and 0.035 pCi/g wet weight for the control location. The differences were not statistically significant.

4. Bottom Sediments

The mean gross beta activity for bottom sediments was 19.4 pCi/g dry weight for indicator locations and 11.7 pCi/g dry weight for the control location. The location with the highest mean was indicator location T-29 (19.8 pCi/g dry weight). Location T-30 had the highest mean potassium-40 activity (21.1 pCi/g dry weight) which was the major contributor to the gross beta activity at all locations.

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Strontium-89 activity was below the LLD of 0.0075 pCi/g dry weight for all locations. The mean strontium-90 activity was 0.027 pCi/g dry weight for indicator locations and 0.015 pCi/g for control location. The location with the highest mean was indicator location T (0.033 pCi/g). Cesium-137 activity was below the LLD of 0.06 pCi/g for control location and 0.15 pCi/g for indicator locations.

V. Methodology Figures and Tables

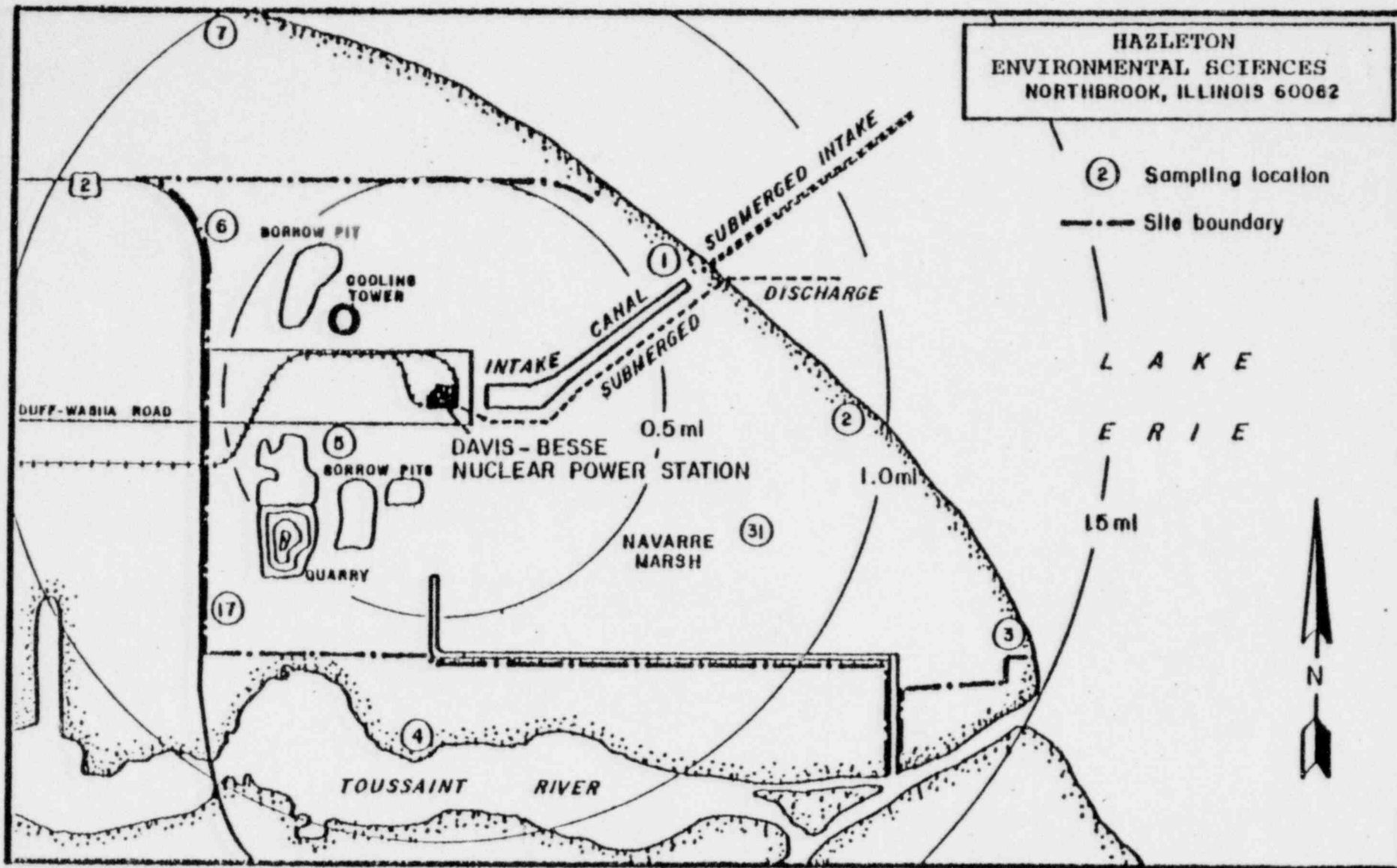


Figure 1. Sampling locations on the site periphery of the Davis-Besse Nuclear Power Station, Unit No. 1

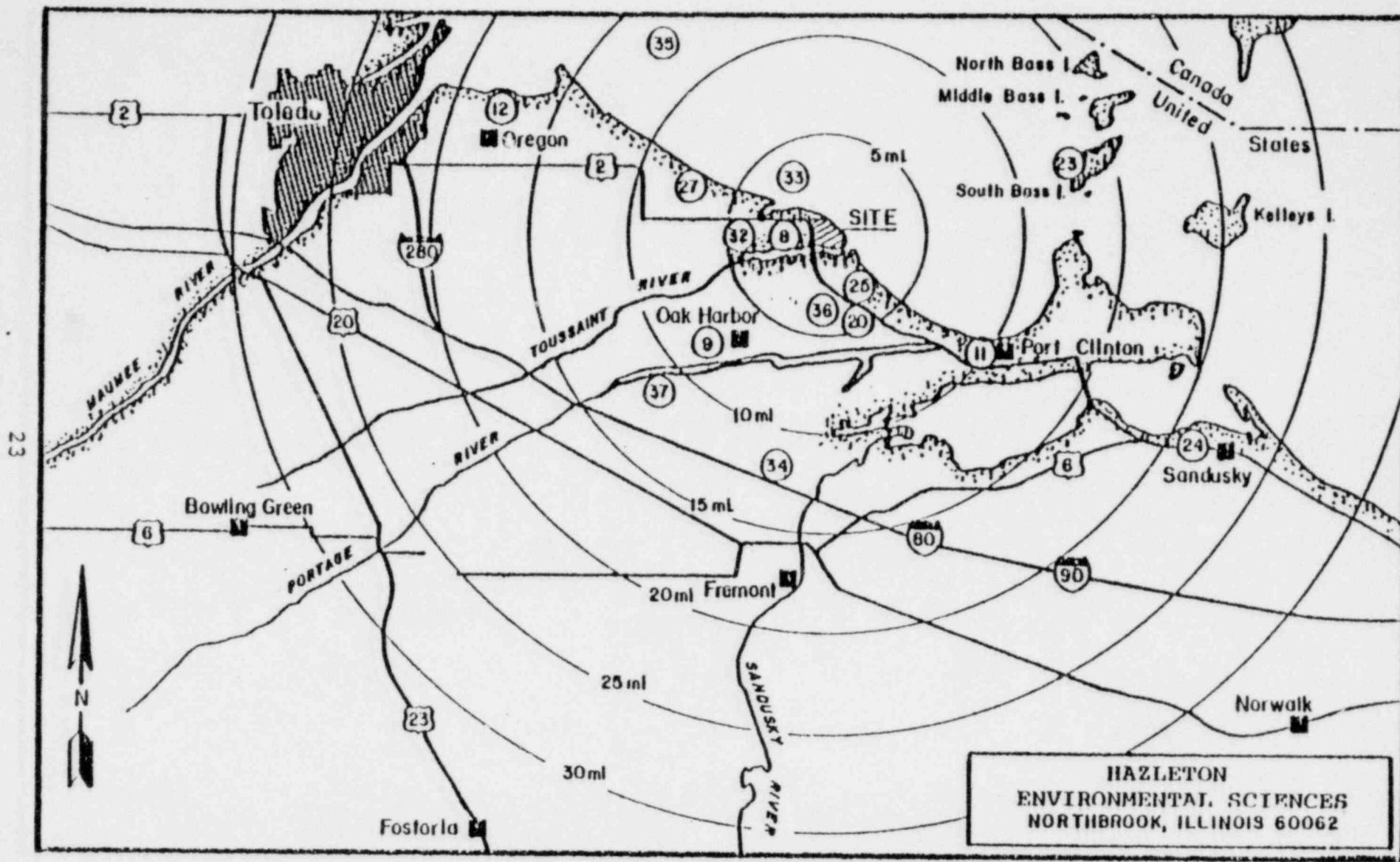


Figure 2. Sampling locations (excepting those on the site periphery), Davis-Besse Nuclear Power Station, Unit No. 1.

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Table 1. Sampling locations, Davis-Besse Nuclear Power Station, Unit No. 1.

Code	Type of Location ^a	Location
T- 1	I	Site boundary, 0.6 miles NE of station, near intake canal.
T- 2	I	Site boundary, 0.9 miles E of station.
T- 3	I	Site boundary, 1.4 miles SE of station, near Toussaint River and storm drain.
T- 4	I	Site boundary, 0.8 miles S of station, near Locust Point and Toussaint River.
T- 5	I	Main entrance to site, 0.25 miles W of station.
T- 7	I	Sand Beach, 0.9 miles NNW of station.
T- 8	I	Earl Moore Farm, 2.7 miles WSW of station.
T- 9	C	Oak Harbor, 6.8 miles SW of station.
T-11	C	Port Clinton, 11.5 miles SE of station.
T-12	C	Toledo, 23.5 miles WNW of station.
T-17	I	Irv Fick's well onsite, 0.7 miles SW of station.
T-20	C	Daup Farm, 5.4 miles SSE of station.
T-23	C	Put-In-Bay Lighthouse, 14.3 miles ENE of station.
T-24	C	Sandusky, 24.9 miles SE of station.
T-25	I	Winter Farm, 1.3 miles S of station.
T-27	C	Magee Marsh, 5.3 miles WNW of station.*
T-28	I	Unit 1 treated water supply, onsite.
T-29	I	Lake Erie, Intake area, 1.5 miles NE of station.
T-30	I	Lake Erie, discharge area, 0.9 miles ENE of station.
T-31	I	Onsite.

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Table 1. (continued)

Code	Type of Location ^a	Location
T-32	I	Land, within 5 miles radius of station.
T-33	I	Lake Erie, within 5 miles radius of station.
T-34	C	Land, greater than 10 miles radius of station.
T-35	C	Lake Erie, greater than 10 miles radius of station.
T-36	I	Miller Farm, 3.7 miles S of station (or the private garden or farm having the highest X/Q).
T-37	C	Fruit stand, 12.0 miles SW of station (or the farm 10 to 20 miles from the site in the least prevalent wind direction).

^a I = Indicator locations; C = Control locations.

Table 2. Type and frequency of collection.

Sampling Location Type		Weekly				Monthly	Quarterly	Semi-Annually			Annually
1	I	AP	AI			TLD	TLD				SO
2	I	AP	AI			TLD	TLD				SO
3	I	AP	AI	SWU		TLD	TLD				SO
4	I	AP	AI			TLD	TLD				SO
5	I					TLD	TLD				
7	I	AP	AI			TLD	TLD	WW			SO
8	I	AP	AI			TLD	M ^a	TLD	VE ^b	AF ^c	SO
9	C	AP	AI			TLD		TLD			SO
11	C	AP	AI	SWU	SWT	TLD					SO
12	C	AP	AI	SWU	SWT	TLD		TLD			SO
17	I							WW			
20	C						M ^a				
23	C	AP	AI			TLD		TLD			SO
24	C					TLD	M ^a	TLD			
25	I								VE ^b		
27	C	AP	AI			TLD		TLD	WW	BS	SO
28	I			SWU	SWT					BS	
29	I									BS	
30	I									BS	
31	I								WL		SMW
32	I								ME		
33	I									F ^d	WF ST
34	C								ME	VE ^b	AF ^c
35	C									F ^d	
36	I					GLV					
37	C					GLV					

^a Semi-monthly during the grazing season, May through October.

^b Two varieties from each location.

^c Cattlefeed collected during the 1st quarter, grass collected during 3rd quarter.

^d Two species from each location.

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Table 3. Sample codes used in Table 2.

Code	Description
AP	Airborne Particulate
AI	Airborne Iodine
TLD (M)	Thermoluminescent Dosimeter - Monthly
TLD (Q)	Thermoluminescent Dosimeter - Quarterly
SWU	Surface Water - Untreated
SWT	Surface Water - Treated (tap)
WW	Well Water (Ground Water)
BS	Bottom Sediments
SO	Soil
M	Milk
ME	Domestic Meat
WL	Wildlife
F	Fish
VE	Fruits and Vegetables
SMW	Smartweed
AF	Animal Feed (silage, grain, grass)
WF	Waterfowl
ST [*]	Snapping Turtle
GLV	Green Leafy Vegetables

Table 4. Sampling summary.

Sample Type	Collection Type and Frequency ^a	Number of Locations	Number of Samples Collected	Number of Samples Missed	Remarks
<u>Air Environment</u>					
Airborne particulates	C/W	11	561	11	See text p.
Airborne iodine	C/W	11	560	12	See text p.
TLD's	C/M	13	156	0	
	C/Q	13	52	0	
<u>Terrestrial Environment</u>					
Milk (May-Oct.)	G/SM	3	36	0	
(Nov.-Apr.)	G/M	3	18	0	
Groundwater	G/Q	3	11	1	See text p.
Edible meat					
a. Domestic meat	G/SA	2	4	0	
b. Wildlife (one species)	G/SA	1	2	0	
c. Waterfowl	G/A	1	1	0	
d. Snapping turtle	G/A	1	1	0	
Fruits and Vegetables (two varieties from each location)	G/SA	3	12	0	
Green leafy vegetables (during harvest season)	G/M	2	6	0	
Animal-wildlife feed					
a. Cattlefeed	G/A	2	2	0	Collected 1st Q
b. Grass	G/A	2	2	0	Collected 3rd Q
c. Smartweed	G/A	1	1	0	
Soil	G/A	11	17	0	See text p.
<u>Aquatic Environment</u>					
Treated surface water	G/WM	3	156 ^b	0	
Untreated surface water	G/WM	3	143 ^b	13	See text p.
	G/HM	1	52 ^b	0	
Fish (two species)	G/SA	2	8	0	
Bottom sediments	G/SA	3	6	0	

^a Type of collection is coded as follows: C/ = continuous; G/ = grab. Frequency is coded as follows: /HM = hourly grab composited monthly; /WM = weekly grab composited monthly; /W = weekly; /SM = semi-monthly; /M = monthly; /Q = quarterly; /SA = semi-annually; /A = annually.

^b Samples are sent to laboratory weekly.

Table 5. Environmental Radiological Monitoring Program Summary.

Name of facility Davis-Besse Nuclear Power Station Docket No. 50-346
 Location of facility Ottawa, Ohio Reporting period January - December 1978
 (county, state)

Sample Type (Units)	Type and Number of Analyses ^a	LLD ^b	Indicator Locations Mean (F) ^c Range ^c	Location with Highest Annual Mean		Control Locations Mean (F) Range	Number of non-routine Results ^d
				Location ^d	Mean (F) Range		
Airborne Particulates (pCi/m ³)	GB 555 ^f	0.001	0.096 (304/304) (0.015-0.646)	T-9 Oak Harbor 6.8 ml SW	0.108 (51/51) (0.013-0.669)	0.095 (251/251) (0.007-0.669)	0
	Sr-89 8	0.00008	0.00251 (3/4) (0.00017-0.00659)	NA ^g		0.00169 (2/4) (0.00090-0.00248)	0
	Sr-90 8	0.00008	0.00116 (4/4) (0.00027-0.00215)	NA		0.00116 (4/4) (0.00031-0.00217)	0
	γ scan 8						
	Be-7	0.002	0.098 (4/4) (0.077-0.108)	NA		0.101 (4/4) (0.089-0.116)	0
	K-40	0.006	<LLD	NA		<LLD	0
	Nb-95	0.0005	0.0052 (2/4) (0.0044-0.0060)	NA		0.0051 (2/4) (0.0041-0.0060)	0
	Zr-95	0.002	0.005 (1/4)	NA		<LLD	0
	Ru-103	0.0008	0.0074 (2/4) (0.0018-0.0130)	NA		0.012 (1/4)	0
	Ru-106	0.005	0.014 (3/4) (0.009-0.018)	NA		0.016 (1/4)	0
	Cs-134	0.0004	<LLD	NA		<LLD	0
	Cs-137	0.0003	0.0022 (4/4) (0.0009-0.0034)	NA		0.0024 (4/4) (0.0007-0.0043)	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a	LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Location Mean Range	Number of non-routine Results
				Location	Mean (f) Range		
Airborne Particulates (pCi/m ³) (cont.)	Co-141	0.001	0.011 (1/4)	NA	-	0.010 (1/4)	0
	Co-144	0.0016	0.017 (4/4) (0.003-0.030)	NA	-	0.019 (4/4) (0.004-0.035)	0
Airborne Iodine (pCi/m ³)	I-131 540 ^h	0.02	0.03 (5/297) (0.02-0.04)	T-2 0.9 mi E, T-3 1.4 mi SE, T-7 0.9 mi NNW, T-9 6.8 mi SW, T-11 9.5 mi SE	0.04 (5/246)	0.03 (5/243) (0.02-0.04)	0
TLD Monthly (mrem) quarters	Gamma 156	2	15.6 (84/84) (14.3-16.2)	T-24 Toft's Dairy, Sandusky 24.9 mi SE	19.9 (12/12) (17.4-23.2)	17.7 (72/72) (15.7-19.9)	0
TLD Quarterly (mrem/quarter)	Gamma 51	2	14.9 (27/27) (9.6-20.2)	T-24 Toft's Dairy, Sandusky 24.9 mi SE	20.4 (4/4) (18.8-21.2)	17.1 (24/24) (12.1-21.9)	0
Milk (pCi/l)	I-131 54	0.5	<LLD	T-20 Daup Farm 5.4 mi SSE	0.8 (1/18)	0.8 (1/36)	0
	Sr-89 54	3.0	<LLD	T-24 Toft's Dairy, Sandusky 24.9 mi SE	5.5 (1/18)	5.5 (1/36)	0
	Sr-90 54	1.1	2.0 (18/18) (0.6-3.2)	T-24 Toft's Dairy, Sandusky 24.9 mi SE	2.2 (17/18) (1.5-3.1)	1.81 (33/36) (0.6-3.1)	0
	Yucan 54	70	1390 (18/18) (1290-1470)	T-8 Earl Moore Farm 2.7 mi WSW	1390 (18/18) (1290-1470)	1340 (36/36) (1250-1410)	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a	LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
				Location	Mean (f) Range		
Milk (cont.) (pCi/l)	Cs-137	3.8	4.5 (4/18) (4.1-5.4)	T-8 Earl Moore Farm 2.7 mi WSW	4.5 (4/18) (4.1-5.4)	4.2 (7/36) (3.8-5.4)	0
	Ba-140	3.7	<LLD	-	-	<LLD	0
(g/l)	Ca 54	0.01	1.18 (18/18) (1.09-1.38)	T-8 Earl Moore Farm 2.7 mi WSW	1.18 (18/18) (1.09-1.38)	1.15 (36/36) (0.92-1.59)	0
(g/l)	K (stable) 54	0.04	1.58 (18/18) (1.47-1.67)	T-8 Earl Moore Farm 2.7 mi WSW	1.58 (18/18) (1.47-1.67)	1.53 (36/36) (1.42-1.60)	0
(pCi/g)	Sr-90/Ca 54	0.9	1.75 (17/18) (0.9-2.9)	T-24 Toft's Dairy, Sandusky 24.9 mi SE	2.0 (17/18) (1.3-2.7)	1.66 (31/36) (0.9-2.7)	0
(pCi/g)	Cs-137/K 54	2.6	2.9 (3/18) (2.7-3.4)	T-20 Daup Farm 5.4 mi SSE	3.0 (3/18) (2.6-3.6)	2.9 (6/36) (2.6-3.6)	0
Well Water (pCi/l)	GB (SS) 11	0.3	<LLD	-	-	<LLD	0
	GB (DS) 11	1	4.1 (7/7) (3.0-5.5)	T-7 Sand Beach 0.9 mi NNW	4.4 (3/3) (3.0-5.5)	2.8 (2/4) (1.7-3.8)	0
	GB (TR) 11	1	4.1 (7/7) (3.0-5.5)	T-7 Sand Beach 0.9 mi NNW	4.4 (3/3) (3.0-5.5)	2.8 (2/4) (1.7-3.8)	0
	M-3 11	180	240 (4/7) (180-320)	T-7 Sand Beach 0.9 mi NNW	280 (2/3) (240-320)	<LLD	0
	Sr-89 11	2.0	<LLD	-	-	<LLD	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a		LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
					Location	Mean (f) Range		
Well Water (cont.)	Sr-90	11	1.4	1.5 (1/7) -	T-7 Sand Beach 0.9 mi NNW	1.5 (1/3) -	<LLD	0
	γ scan	11						
Edible Meat (pCi/g)	Cs-137		3.7	<LLD	-	-	<LLD	0
	γ scan	8						
	K-40		0.1	1.9 (6/6) (1.5-2.7)	T-31 Onsite 0.6 mi NE	2.0 (3/3) (1.6-2.7)	2.0 (2/2) (1.3-2.6)	0
Fruits and Vegetables (pCi/g wet)	Cs-137		0.02	<LLD	-	-	<LLD	0
	Sr-89	12	0.0083	<LLD	-	-	<LLD	0
	Sr-90	12	0.0048	0.0125 (6/8) (0.0010-0.0336)	T-25 Winter Farm 1.3 mi S	0.0201 (3/4) (0.0010-0.0336)	0.0180 (3/4) (0.0015-0.0409)	0
	γ scan	12						
	K-40		0.1	2.1 (8/8) (1.0-3.9)	T-25 Winter Farm 1.3 mi S	2.2 (4/4) (1.0-3.6)	2.0 (4/4) (0.9-2.8)	0
	Nb-95		0.01	<LLD	-	-	<LLD	0
	Zr-95		0.04	<LLD	-	-	<LLD	0
	Ru-106		0.1	<LLD	-	-	<LLD	0
	Cs-137		0.01	<LLD	-	-	<LLD	0
	Ce-141		0.04	<LLD	-	-	<LLD	0
Ce-144		0.07	<LLD	-	-	<LLD	0	

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Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a		LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
					Location	Mean (f) Range		
Green Leafy Vegetables (pCi/g wet)	I-131	6	0.01	<LLD	-	-	<LLD	0
	γ scan	6						
	K-40		0.1	3.0 (3/3) (1.7-4.8)	T-36 Miller Farm 3.7 mi S	3.0 (3/3) (1.7-4.8)	2.3 (3/3) (1.3-4.1)	0
	Nb-95		0.009	<LLD	-	-	<LLD	0
	Zr-95		0.02	<LLD	-	-	<LLD	0
	Cs-137		0.01	<LLD	-	-	<LLD	0
	Ce-141		0.02	<LLD	-	-	<LLD	0
Animal - Wildlife Feed (pCi/g wet)	Ce-144		0.07	<LLD	-	-	<LLD	0
	γ scan	5						
	Bc-7		0.2	<LLD	-	-	LLD	0
	K-40		0.1	5.0 (3/3) (2.6-6.7)	T-34 Land 25 mi SE	9.7 (2/2) (5.0-14.4)	9.7 (2/2) (5.0-14.4)	0
	Nb-95		0.03	<LLD	-	-	<LLD	0
	Zr-95		0.04	<LLD	-	-	<LLD	0
	Ru-103		0.03	<LLD	-	-	<LLD	0
	Ru-106		0.2	<LLD	-	-	<LLD	0
Cs-137		0.03	0.11 (1/3) -	T-31 Site boundary 0.6 mi NE	0.11 (1/1) -	0.05 (1/2) -	0	

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Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a	LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
				Location	Mean (f) Range		
Animal - Wildlife Feed (pCi/g wet) (cont.)	Ce-141	0.08	<LLD	-	-	<LLD	0
	Ce-144	0.2	0.8 (1/3)	T-31 Site boundary 0.6 mi NE	0.8 (1/1)	<LLD	0
Soil (pCi/g dry)	γ scan 11						
	Be-7	6.7	<LLD	-	-	<LLD	0
	K-40	0.1	19.74 (6/6) (14.67-29.40)	T-9 Oak Harbor 6.8 mi SW	36.72 (1/1)	25.41 (5/5) (10.11-36.72)	0
	Zr-95	0.84	<LLD	-	-	<LLD	0
	Nb-95	0.48	<LLD	-	-	<LLD	0
	Ru-103	1.8	<LLD	-	-	<LLD	0
	Ru-106	0.40	<LLD	-	-	<LLD	0
	Cs-137	0.024	0.599 (5/6) (0.091-1.879)	T-23 Put-in-Bay Lighthouse 14.3 mi ENE	3.439 (1/1)	1.094 (5/5) (0.089-3.439)	0
	Ce-141	7.6	<LLD	T-11 Port Clinton 9.5 mi SE	21.5 (1/1)	21.5 (1/5)	0
	Ce-144	0.50	0.77 (2/6) (0.60-0.93)	T-1 Site boundary 0.6 mi NE	0.93 (1/1)	<LLD	0
Treated Surface Water (pCi/l)	GB (SS) 36	0.4	<LLD	-	-	<LLD	0
	GB (DS) 36	0.4	2.9 (12/12) (2.2-4.6)	T-11 Port Clinton tap water 9.5 mi SE	3.6 (12/12) (2.5-4.9)	3.2 (24/24) (2.1-4.9)	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a		LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
					Location	Mean (f) Range		
Treated Surface Water (pCi/l) (cont.)	GB (TR)	36	0.4	2.9 (12/12) (2.2-4.6)	T-11 Fort Clinton tap water 9.5 mi SE	3.6 (12/12) (2.5-4.9)	3.2 (24/24) (2.1-4.9)	0
	H-3	12	180	280 (4/4) (250-310)		280 (8/8) (260-370)	0	
	Sr-89	12	2.0	<LLD		-	<LLD	0
	Sr-90	12	0.9	<LLD		-	<LLD	0
	γ scan	12						
	Cs-137		3.7	<LLD	-	<LLD	0	
Untreated Surface Water (pCi/l)	GB (SS)	45	0.5	2.5 (18/21) (0.5-7.0)	T-3 Lake Erie, site boundary, 1.4 mi SE of Toussaint R. and storm drain	3.4 (9/9) (1.0-7.0)	2.1 (14/24) (0.6-5.4)	0
	GB (DS)	45	0.5	4.2 (21/21) (1.8-8.6)	T-3 Lake Erie, site boundary, 1.4 mi SE of Toussaint R. and storm drain	5.1 (9/9) (3.1-8.6)	4.2 (24/24) (2.2-7.6)	0
	GB (TR)	45	0.5	6.4 (21/21) (2.3-15.6)	T-3 Lake Erie, site boundary, 1.4 mi SE of Toussaint R. and storm drain	8.5 (9/9) (4.6-15.6)	5.4 (24/24) (3.0-13.0)	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a		LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routing Results
					Location	Mean (f) Range		
Untreated Surface Water (pCi/l) (cont.)	H-3	15	170	310 (1/7) (170-480)	T-11 Port Clinton water intake 9.5 mi SE	340 (4/4) (320-390)	320 (8/8) (180-430)	0
	Sr-89	15	2.0	<LLD	-	-	<LLD	0
	Sr-90	15	0.9	1.0 (3/7) (0.9-1.2)	T-12 Toledo water intake 23.5 mi WNW	1.1 (1/4)	1.1 (1/8)	0
	γ scan	15						
	Cs-137		3.7	<LLD	-	-	<LLD	0
Fish (pCi/g wet)	GB	8	0.02	2.46 (4/4) (1.78-2.98)	T-33 Lake Erie 1.5 mi NE	2.46 (4/4) (1.78-2.98)	2.15 (4/4) (1.31-3.67)	0
	γ scan	8						
	K-40		0.1	2.2 (4/4) (2.0-2.4)	T-33 Lake Erie 1.5 mi NE	2.2 (4/4) (2.0-2.4)	2.1 (4/4) (1.6-2.5)	0
	Cs-137		0.009	0.027 (3/4) (0.011-0.031)	T-35 Lake Erie 15 mi NE	0.035 (3/4) (0.012-0.050)	0.035 (3/4) (0.012-0.050)	0
Bottom Sediments (pCi/g dry)	GB	6	1.4	19.4 (4/4) (12.9-25.2)	T-29 Lake Erie, intake area 1.5 mi NE	19.8 (2/2) (19.7-19.9)	11.7 (2/2) (10.2-13.1)	0
	Sr-89	6	0.0075	<LLD	-	-	<LLD	0
	Sr-90	6	0.008	0.027 (4/4) (0.014-0.033)	T-29 Lake Erie, intake area 1.5 mi NE	0.033 (2/2)	0.015 (2/2) (0.009-0.021)	0

Table 5. (continued)
 Name of facility Davis-Besse Nuclear Power Station

Sample Type (Units)	Type and Number of Analyses ^a	LLD ^b	Indicator Locations Mean (f) Range	Location with Highest Annual Mean		Control Locations Mean (f) Range	Number of non-routine Results
				Location	Mean (f) Range		
Bottom Sediments (pCi/g dry) (cont.)	γ scan 6 K-40	0.1	20.6 (4/4) (16.2-26.0)	T-30 Lake Erie, discharge area 0.9 mi WNW	21.1 (2/2) (16.2-26.0)	16.1 (2/2)	0
	Cs-137	0.06	0.15 (3/4) (0.06-0.27)	T-29 Lake Erie intake area 1.5 mi NE	0.20 (2/2) (0.13-0.27)	<LLD	0

^a GB - gross beta, SS - suspended solids, DS - dissolved solids, TR - total residue.
^b LLD - nominal lower limit of detection based on 3 sigma counting error for background sample.
^c Mean based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses (F).
^d Locations are specified by station code (Table 1) and distance (miles) and direction relative to reactor site.
^e Non-routine results are those which exceed ten times the control station value.
^f Six collection periods with low results have been excluded in the determination of the means and ranges of gross beta in air particulates. These results were unreliable due to apparent pump malfunction.
^g Quarterly composites of all samples from indicator locations and control locations were gamma scanned separately. Thus, the location with the highest annual mean cannot be identified.
^h Twenty results have been excluded in the determination of the means and ranges of airborne iodine-131. These results have been excluded due to apparent pump malfunction or low volume.

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XVIII

SECTION 4.1
OPERATIONAL NOISE SURVEILLANCE