KEWAUNEE NUCLEAR POWER PLANT

ANNUAL OPERATING REPORT

1978

/ICE CORPORATION

LIGHT COMPANY

TRIC COMPANY

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1.0 INTRODUCTION

The Kewaunee Nuclear Power Plant is a pressurized water reactor Licensed at 1650 MWt. It is located in Kewaunee County along Lake Michigan's northeast Wisconsin shoreline and is jointly owned by Wisconsin Public Service Corporation, Wisconsin Power and Light Company and Madison Gas and Electric Company. The nuclear steam supply system was purchased from Westinghouse Electric Corporation and is rated for a 1721.4 MWt output. The turbine-generator was also purchased from Westinghouse and is rated at 540 MWe net. The architect/engineer was Pioneer Service and Engineering (PSE) from Chicago.

The Kewaunee Nuclear Power Plant achieved initail criticality on March 7, 1974. Initial power generation was reached April 8, 1974 and the plant was declared commerical on June 16, 1974. Since being declared commercial, Kewaunee has generated 16,570,300 MW hours of electricity with a net plant capacity factor of 73.9% (using net DER).

1.1 Highlights

During the year, the Kewaunee Nuclear Plant was base loaded. The unit was operated at a 85.5% capacity factor (using net MDC) with a gross efficiency of 32.9%. The unit and reactor availability was 89.5% and 90.4%, respectively. Table 2.1 is a compilation of the monthly summaries of the operating data, Table 2.2 contains the yearly and total summaries of the operating data, and Figure 1.1 provides a histogram of the average daily electrical output of the Kewaunee Plant for 1978.

On April 22, the unit was removed from service for refueling number three. Fourty fresh assemblies were loaded for cycle IV. Refueling was completed on May 15; and the unit was back on line on May 28.

2.0 SUMMARY OF OPERATING EXPERIENCE

January

For the month of January, Kewaunee was base loaded at 100% power with one scheduled weekend backdown for turbine governor and stop valve testing.

PLANT SHUTDOWNS: There were no plant shutdowns in the month of January.

February

For the month of February, Kewaunee was base loaded at 100% power. No shutdowns or power reductions occurred during the month. The turbine governor and stop valve operability tests were completed satisfactorily.

PLANT SHUTDOWNS: There were no plant shutdowns in the month of February.

March

For the month of March, Kewaunee was base loaded at 100% power with the exception of March 19, when generation was reduced to 288MW for turbine governor and stop valve operability tests, plus cleaning of the condensate pump strainers.

PLANT SHUTDOWNS: There were no plant shutdowns for the month of March.

April

Kewaunee was base loaded at 100% power for the first part of April until April 22, when the unit was removed from service for refueling number 3. The reactor coolant system was cooled down to 425 psig and 350°F for a modification on the residual heat removal system.

On April 29, the reactor was in refueling shutdown with the Reactor Coolant System drained below the reactor vessel flange.

PLANT SHUTDOWN: April 22 - Scheduled shutdown - 214.6 hours

The plant was shutdown for refueling.

May

For the greater part of May, the annual refueling outage continued, Fuel movement started on May 5 and was completed May 15.

On May 20, the reactor coolant system was filled, and plant recovery was initiated. After completion of rod drop testing, the reactor was brought critical on May 26.

After several days of zero power physics testing, the unit was put on the line May 28. Turbine overspeed trip testing was performed on May 29 and the unit was escalated to 75% reactor power for the flux mapping required for the Power Range Nuclear Instrumentation calibration.

PLANT SHUTDOWNS: April 22 - scheduled shutdown - 660.2 hours Refueling Shutdown continues.

May 28 - forced outage - 4.5 hours while taking the unit off line for overspeed test of the turbine, auto unblock of the IR trip occurred too soon resulting in reactor trip.

May 28 - scheduled outage - 1.5 hours Unit taken off line for post-refueling overspeed test of turbine.

June

The Power Range Nuclear Instrumentation Calibration was completed and the unit returned to full load on June 5.

On June 7, speed control was lost to Heater Drain Pump 1A and generation was reduced to 490 MW for repair of the speed control. The unit was returned to full load on the same day.

On June 8, the number one turbine control valve became erratic such that the unit could not maintain a stable output. Generation was reduced to 490 MW and the hydraulic fluid to the valve isolated. The unit was returned to full load on June 9.

On June 24, the unit was removed from service to repair the turbine E-H control system. During the power reduction, the reactor tripped on Low-Low Steam Generator level when a steam line safety valve lifted below its setpoint. The unit was returned to service on June 25 and was at full load on June 27.

On June 27, a trip on overpower delta T occurred from full load when it was assumed the number one turbine control valve opened. Subsequent investigation several days later revealed that the feedwater heater bypass valve had opened above its setpoint. When the unit was out of service, the number one turbine control valve was again isolated. The unit was returned to service the same day and was at full load on June 27.

On June 28, a similiar transient occurred as happened on June 27 except the unit did not trip.

At the end of the month, the unit was limited to 515 MW pending further investigation.

The unit was load following for a significant portion of the month.

PLANT SHUTDOWNS: June 24 - scheduled shutdown - 25.2 hours. A weekend outage was taken to investigate erratic turbine control valve operation and to make adjustments to generator exciter balance.

June 27 - Forced Shutdown - 3.2 hours Spurious opening of a feedwater heater bypass valve resulted in a unit runback. Resulting transient caused an Overpower Delta T trip.

July

On July 12, a three hour capacity test was run with 515 MW net being the maximum average generation. Prior to the test the number one turbine control valve was unisolated and returned to service.

On July 16, the monthly turbine governor and stop valve test was completed.

Over the past several months, it was observed that the feedwater pump suction pressure was slowly decreasing. Investigation revealed that the pressure drop across the condensate side of feedwater heaters 14A and 14B was excessive. Therefore, on July 29, feedwater heater 14B was removed from service for inspection and cleaning.

The unit was operated at reduced load for a significant portion of the month due to light system demands.

PLANT SHUTDOWNS: There were no plnat shutdowns for the month of July.

August

On August 10, speed control was lost due to Heater Drain Pump 1A. Unit load was reduced to 500 MW(e) for repair. The heater drain pump was returned to service on August 12.

On August 12, Feedwater Heater 14B was returned to service and Feedwater Heater 14A was removed from service for cleaning.

On August 13, the monthly turbine governor and stop valve test was completed.

On August 16, Feedwater Heater 14A was returned to service and the unit was released for full load.

On August 29, the circulating water discharge temperature reached 80°F and extra monitoring was started. On August 31, load was reduced 10MW(e) to preclude reaching 86°F discharge temperature.

The unit was operated at reduced load for a significant portion of the month due to light system demands.

PLANT SHUTDOWNS: There were no plant shutdowns in the month of August.

September

On September 10, the monthly turbine governor and stop valve test was completed.

On September 14, rod K-7 became misaligned with its bank by 18 steps. The core hot channel factors and the quadrant tile were within Technical Specification limits. Subsequent movement of rod K-7 caused the rod to drop and trip the reactor and turbine. A blown movable gripper fuse for rod K-7 was found. The unit was back on the line in approximately two hours.

Several times during the month unit generation was reduced because of circulating water discharge temperature reaching Technical Specification limits.

The unit was operated at reduced load for a significant portion of the month due to light system demands.

PLANT SHUTDOWNS: September 14 - forced Shutdown - 2.2 hours. A blown fuse in a CRDM stationary gripper circuit caused a rod drop during an attempt to move the rod which resulted in a negative rate trip.

October

On October 15, the monthly turbine governor and stop valve test was completed; and unit load was decreased for condenser tube leak checking and plugging.

The unit was operated at reduced load for a minor portion of the month due to light system demand.

PLANT SHUTDOWNS: There were no plant shutsowns in the month of October.

November

On November 2, unit load was decreased to 510 MW(e) gross for repair of Heater Drain Pump 1A.

On November 5, a reactor coolant pump bus undervoltage caused a reactor turbine trip. Cause of the undervoltage could not be determined. The unit was returned to service the same day.

On November 7, the repair of Heater Drain Pump 1A was completed and the unit returned to full load.

On November 11, low steam generator level caused a reactor-turbine trip. A plant transient was caused by a bus 1-5 lock out which occurred when the 138KV and 345 KV substaions were connected through the 4KV bus 1-5.

The unit was operated at reduced load for a minor portion of the month due to light system demands.

PLANT SHUTDOWNS: November 5 - Forced shutdown - 3.6 hours. A momentary undervoltage on the RCP and FWP bus caused a reactor trip.

November 11 - Forced shutdown - 6.6 hours. A procedure for substation breaker testing resulted in tying together two transmission lines through the plant internal distribution. The resulting relay actions caused the unit to trip.

December

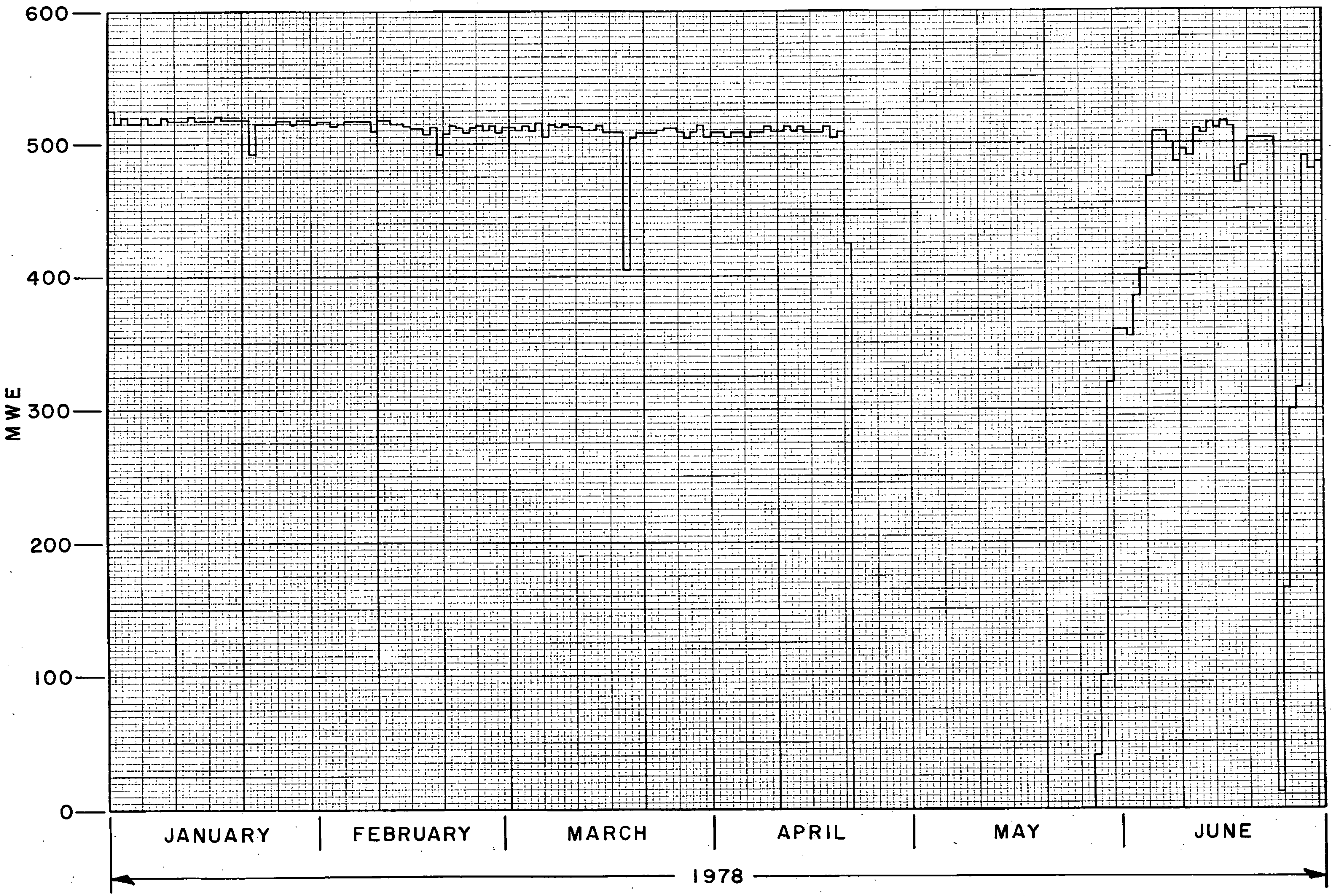
On December 10, unit load was decreased to 390 MW(e) for the monthly turbine steep valve test.

On December 23, the hydraulics to number 1 turbine control valve were isolated to disable the valve in the closed position because of erratic operation.

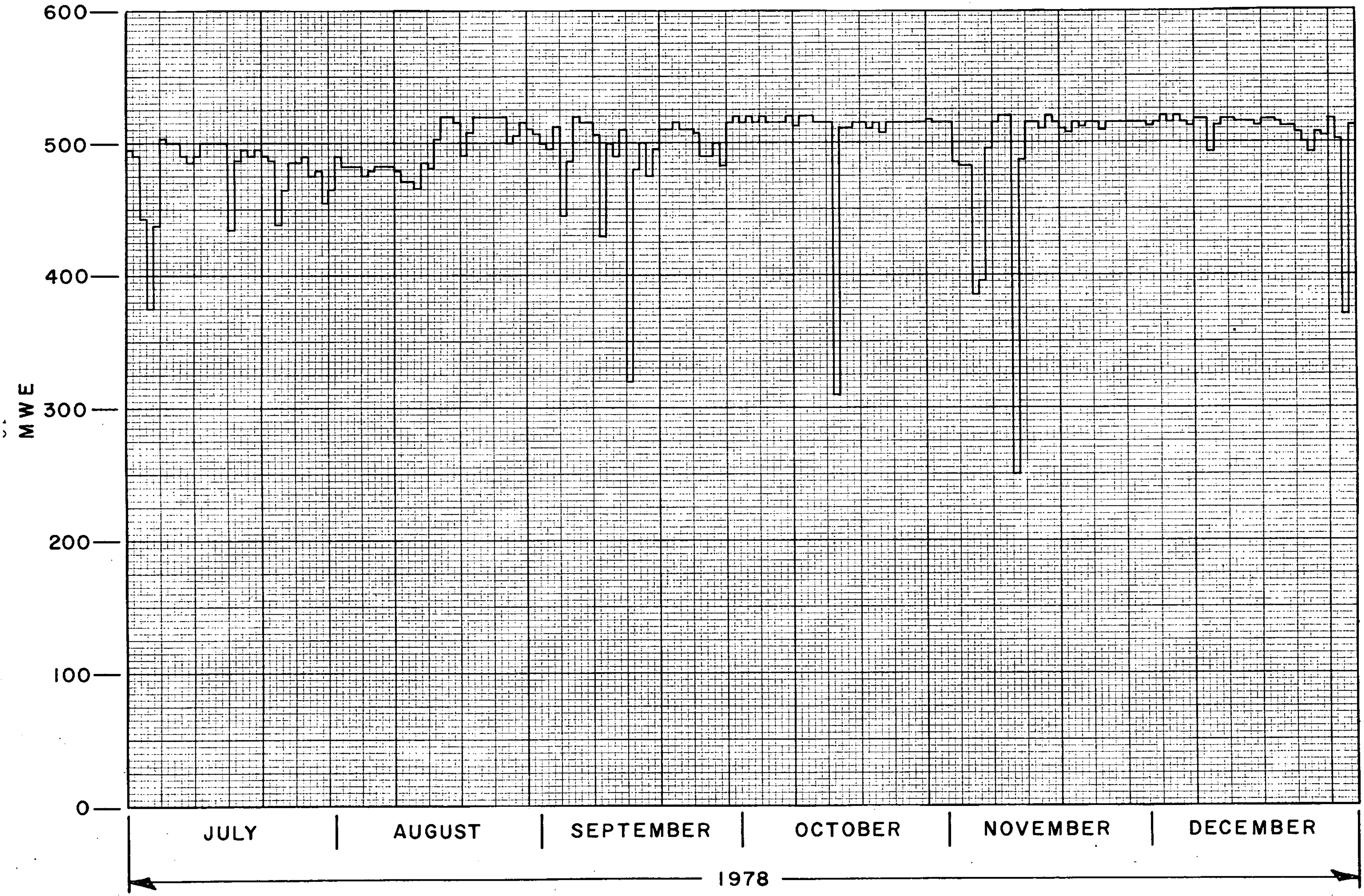
On December 26, unit load was decreased to allow repair of heater drain pump 1B motor. The pump was returned to service on December 27. Heater Drain Pump 1B was again removed from service for repair on December 29. It was returned to service on the same day.

On December 30, unit load was decreased to 140 MW(e) to allow for the monthly stop valve test with the number 1 control valve isolated shut.

PLANT SHUTDOWNS: There were no plant shutdowns in the month of December.



KEWAUNEE POWER HISTORY
AVERAGE DAILY MWE - NET



KEWAUNEE POWER HISTORY
AVERAGE DAILY MWE - NET

ELECTRICAL POWER GENERATION DATA (1978)

MONTHLY

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Hours RX was critical	744.	672.	744.	504.8	116.8	711.
RX Reserve shutdown hours	0.	0.	0.	0.	0.	9.
Hours Generator On-Line	744.	672.	744.	504.4	77.8	691.6
Unit Reserve shutdown hours	0.	0.	0.	0.	0.	0.
Gross Thermal Energy Generated (MWH)	1,218,479.	1,098,398.	1,203,881.	811,877.	72,462.	1,016,869.
Gross Electrical Energy Generated (MWH)	402,900.	360,900.	395,100.	266,900.	21,500.	335,600.
Net Electrical Energy Generated (MWH)	384,697.	344,485.	376.678.	254,103.	19,817.	318,381.
RX Service Factor	100.	100.	100.	70.2	15.7	98.8
RX Availability Factor	100.	100.	100.	70.2	15.7	100.
Unit Service Factor	100.	100.	100.	70.1	10.5	96.1
Unit Availability Factor	100.	100.	100.	70.1	10.5	96.1
Unit Capacity Factor (using MDC net)	99.2	98.4	97.2	67.8	5.1	84.9
Unit Capacity Factor (Using DER net)	96.6	95.8	94.6	66.1	5.0	82.7
Unit Forced Outage Rate	0.	0.	0.	0.	5.4	0.5
Hours In Month	744.	672.	744.	719.	744.	720.
Net MDC (MWe)	521.	521.	521.	521.	521.	521.

Table 2.1

ELECTRICAL POWER GENERATION DATA (1978)

MONTHLY

	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Hours RX was critical	744.	744.	718.4	745.	713.4	744.
RX Reserve Shutdown Hours	0.	0.	0.	0.	6.6	0.
Hours Generator On-Line	744.	744.	717.8	745.	709.8	744.
Unit Reserve Shutdown Hours	0.	0.	0.	0.	0.	0.
Gross Thermal Energy Generated (MWH)	1,129,811.	1,182,936.	1,137,041.	1,208,085.	1,129,396.	1,200,591.
Gross Electrical Energy Generated (MWH)	374,900.	388,600.	372,800.	398,500.	373,400.	396,200.
Net Electrical Energy Generated (MWH)	356,107.	369,479.	354.255.	379,463.	355,287.	377,709.
RX Service Factor	100.	100.	99.8	100.	99.1	100.
RX Availability Factor	100.	100.	99.8	100.	100.	100.
Unit Service Factor	100.	100.	99.7	100.	98.6	100.
Unit Availability Factor	100.	100.	99.7	100.	98.6	100.
Unit Capacity Factor (Using MDC Net)	92.9	96.4	94.8	98.1	95.1	97.8
Unit Capacity Factor (Using DER Net)	89.5	92.8	92.0	95.2	92.2	94.9
Unit Forced Outage Rate	0.	0.	0.3	0.	1.4	0.
Hours in Month	744.	744.	720.	745.	720.	744.
Net MDC (MWe)	515.	519.	519.	519.	519.	517.

Table 2.1 (Continued)

ELECTRICAL POWER GENERATION DATA

1978

	YEAR	CUMULATIVE
Hours RX was critical	7,901.4	33,963.7
RX Reserve Shutdown Hours	15.6	2,007.0
Hours Generator On-Line	7,838.3	33,072.2
Unit Reserve Shutdown Hours	0.	10.
Gross Thermal Energy Generated MWH	12,409,826.	50,203,281.
Gross Electrical Energy Generated (MWH)	4,087,300.	16,570,300.
Net. Elec. Energy Generated (MWH)	3,890,461.	15,759,789.
RX Service Factor	90.2	85.2
RX Availability Factor	90.4	90.3
Unit Service Factor	89.5	83.0
Unit Availability Factor	89.5	83.0
Unit Capacity Factor	85.5	75.3
Unit Capacity Factor (Using DER Net)	83.0	73.9
Unit Forced Outage Rate	0.3	3.9
Hours in Reporting Period	8,760	39,841

Table 2.2

3.0 PLANT MODIFICATIONS, 10 CFR 50.59(b)

No modifications were installed during 1978 which introduced an unreviewed safety question and, therefore, no modifications required prior NRC approval. The following summary of modifications includes those significant modifications completed during 1978 and not previously reported.

Fuel Handling System

An interlock was installed in the manipulator crane hoist drive-up circuit consisting of a limit switch in the Dillon weight indicator paralleling the gripper engaged switch. This interlock provides additional backup on operator's action, preventing the raising of a fuel assembly by a disengaged gripper. (DCR 621)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Reactor Coolant System

A foam fire protection system for both reactor coolant pumps was installed per NRC Technical Position Statement of Fire Protection for Nuclear Power Plants. (DCR 623)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Chemical & Volume Control System

The pipe run from the discharge of relief valve LD-13 to the "tee" connection with the seal water return line was increased. This change was made to allow the installation of a freeze seal to work on relief valve LD-13. (DCR 656)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Control Rod Drive System

The part length control rods were removed and replaced with thimble plugging devices. The part length control rod use is restricted by Tech Specs and are not utilized for reactor operation. This change reduces the time required for refueling by eliminating latching and unlatching steps and reduces exposure to personnel during refueling. (DCR 684)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Security System

The plant's security system has been upgraded in accordance with 10 CFR 73.55. This consisted of the addition of a perimeter fence alarm, computer control over personnel admittances and control of doors and TV monitors. (DCR 692)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

CO_2 Fire Protection System

A total flooding manually actuated CO_2 fire protection system was installed in the relay room. (DCR 576)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Fire Protection System

Eight fire fighting hose reel stations were installed in the auxiliary building. These were installed to satisfy new standards for possible fires in electrical penetrations and cable trays. (DCR 597)

Summary of Safety Evaluation:

This modification is not nuclear safety related.

Turbine Building Ventilation System

Additional air handling equipment was installed in the turbine building to provide better cooling to equipment in the turbine building basement.

Summary of Safety Evaluation:

This modification is not nuclear safety related.

4.0 LICENSEE EVENT REPORTS

Included in this section is a summary of the 37 Licensee Event Reports (LER) submitted to the NRC in 1978 in accordance with the requirements of Technical Specifications. None of the LER's in 1978 posed a threat to plant operation or public safety.

LER 78-01

During full power operation, scheduled preventive maintenance was being performed on the fan coil unit control breakers. Work was completed on units 1B and 1C and was in progress on unit 1A when unit 1B tripped on overcurrent resulting in two units being out of service. Unit 1A we immediately returned to service. Unit 1B was known to have a motor bearing that was failing, however, the plant staff felt it was operable for plant staff use.

LER 78-02

A review of the calibration procedure for the pressurizer pressure transmitters revealed that a head correction for the transmitters had not been applied. This caused all readings to be slightly above the true readings. The low pressure safeguards actuation signal would have occurred slightly below Technical Specification limits. The safety significance of this error is low, due to the conservative margin between the Technical Specification limit and the pressure at which safeguard actuation is initiated in the safety analysis as described in the FSAR.

LER 78-03

During full power operation, one of four service water (SW) pumps failed to start. This placed the facility under a limiting condition for operation. The cause was found to be a faulty circuit breaker. The breaker was replaced, and the pump placed back in service in two hours.

LER 78-04 and LER 78-05

During full power operation the same component cooling pump failed to start on two different occasions. The first incident was caused by a faulty static trip device which was repaired within 24 hours. The cause of the second failure could not be determined.

LER 78-06

Surveillance testing during full power operation showed that one of two blowdown line containment isolation valves would not shut completely. Dry, hard packing caused the failure of this limitorque operated valve by imposing excessive torque requirements on the operator. The valve was repacked and has operated satisfactorily during subsequent testing.

LER 78-07

During full power operation scheduled surveillance revealed that one of three pressurizer level channels had a safety injection trip setpoint 6.1% below that required by Technical Specifications. Investigation showed no indication of instrument malfunction. It is possible that the SI trip bistable adjustment was inadvertently disturbed or instrument drift occurred. The trip setpoint was readjusted and the channel returned to service.

LER 78-08

Surveillance testing of the component cooling system during full power operation revealed that a containment isolation valve on the excess letdown heat exchanger return line would not shut completely. The downstream manual isolation valve was shut until repair could be completed. The cause of the failure was found to be an oxide layer on the torque switch contacts. The contacts were cleaned and the valve placed back in service.

LER 78-09

Surveillance testing of the safety injection system during full power operation indicated that a train B motor operated containment sump isolation valve would not fully open. The cause of this valve operation failure could not be determined.

LER 78-10

Our NSS supplier notified us of a generic error in the calculational code for ECCS LOCA analysis. The code does not properly account for the zircalloy/water reaction. Our supplier is currently working on the problem; however, no changes in normal operation are necessary due to this problem.

LER 78-11

During full power operation Radiation Monitor R-15 was taken out of service due to a faulty low voltage power supply. Monitor R-19 was placed in operation, but the operator failed to open the sample valves. Results of S/G blowdown samples indicate there was no release to the environment and no effect on public safety.

LER 78-12

Upon completion of the monthly D/G four hour run surveillance test with the reactor at full power, the D/G source breaker could not be tripped from the control panel and had to be tripped locally. The cause was a failed trip coil.

LER 78-13

Surveillance testing of the safety injection system during full power operation indicated that a Train B motor operated containment sump isolation valve would not fully open. The failure is believed to be caused by valve packing which has reached its end of useful life.

LER 78-14

Surveillance testing indicated that one Sheild Building Vent (SBV) train would not draw a measurable vacuum in the annulus. This was caused by a faulted static pressure controller which failed to open a recirculation fan exhaust check damper.

LER 78-15

During design change work on the RHR system with the reactor shutdown, a RHR vent valve was opened in the auxiliary building and the containment integrity was breached

LER 78-16

The condenser hotwell was not sampled prior to discharge during routine shutdown operations. There was no effect on plant operation, public health or the environment.

LER 78-17

Surveillance testing during refueling shutdown indicated that one steam flow transmitter was out of calibration resulting in high steam flow and High-High steam flow trip settings less conservative than Technical Specification requirements.

LER 78-18

Surveillance testing during the refueling shutdown indicated that one pressurizer level transmitter was out of calibration such that the reactor high level trip signal setting was less conservative than required by Technical Specifications.

LER 78-19

Surveillance testing during refueling shutdown indicated that one Reactor Cooling System flow transmitter on each loop was less conservative than required by Technical Specifications due to instrument drift.

LER 78-20

During refueling, visual inspection of snubbers per surveillance test requirements revealed two snubbers whose operability was questioned. These snubbers were tested, and one was found to be inoperable. The cause was degraded seals which permitted the hydraulic fluid to leak and drain the reservoir. The seals were replaced and the snubber returned to service.

LER 78-21

On two occasions during refueling, train A of Shield Building Vent would not draw a measurable vacuum. The problem on each occasion was due to the photo-electric switch in the static pressure controller. Repair of the controller corrected the problem.

LER 78-22

While at hot shutdown during startup from refueling one channel of pressurizer level indication was reading high due to instrumentation drift in the level transmitter. This caused the low pressurizer level safety injection initiation signal setting to be less conservative than required by Technical Specifications. The transmitter was recalibrated and returned to service.

LER 78-23

During plant startup from refueling, a main steam system snubber was found with an empty reservoir due to failed seals. The snubber was replaced with an operable spare.

LER 78-24

During full power operation, the supply breaker to MCC1-62F has opened a total of seven times. No apparent cause for these trips has been found. Since two different breakers have tripped while in service in

MCC1-62F, the problem does not appear to be in the breaker.

LER 78-25

During normal load follow operation, the containment air sampling inlet valve was found shut. The valve had shut approximately 39 hours previously when its power supply was interrupted, however, leakage of the particulate monitor cover gasket permitted flow through the instrument giving an erroneous indication of normal operation. The gasket was replaced and the unit response was satisfactory on retest.

LER 78-26

During steady full power operation, while performing D/G surveillance testing, load adjustment for 1A D/G could not be controlled from the control room. After manually exercising the control mechanism locally, normal control operation from the control room was restored.

LER 78-27

During steady full power operation, surveillance testing revealed that the safety injection initiation trip setting for one of three channels of steam pressure instrumentation was less conservative than specified by Technical Specifications. Instrument drift of the Foxboro bistable caused this less conservative trip setting. The bistable was recalibrated and the channel was returned to service.

LER 78-28

During full power operation, the operating coolant charging pump failed such that it would only operate at full speed. Since another coolant charging pump was tagged out for routine maintenance, this left the facility with only one coolant charging pump, which is a limiting condition of operation. The cause of the problem was a failed transistor in the hand control station. The transistor was replaced and the coolant charging pump returned to service.

LER 78-29

During full power operation, a service water pump seal assembly was found to be out of position. The cause was worn pump bearings due to insufficient cooling/lubricating water, which caused the seal assembly to shift. The failed pump was replaced with a spare and returned to service.

LER 78-30

During full power operation, the shaft enclosing tube on a service water pump lifted, due to excessive undercutting of the tube at the internal end threads during manufacture. The failed pump was replaced with a spare and returned to service.

LER 78-31

During full power operation, a small leak was discovered on the discharge of a coolant charging pump. The leak was from a hairline crack where the discharge pipe is welded to the charging pump block. The weld was ground out and the discharge line flange was aligned and rewelded.

LER 78-32

A cam in the upper load limit switch was found to be out of adjustment on Deisel generator 1A during the monthly test. This condition may have caused the D/G to be unable to fully respond in an accident condition. The cam was re-adjusted and the D/G returned to full operability.

LER 78-33

Management review of daily chemistry records indicated that results of pH analysis of a grab sample from a water softening unit regenerating waste water were not recorded on the log sheet. This is in violation of the Environmental Technical Specification.

LER 78-34

During surveillance testing at full power, train B reactor trip breaker would not open immediately when a trip signal was applied. The problem was due to normal wear on an adjustable reset lever. The lever was re-adjusted, and the breaker tested satisfactorily.

LER 78-35

An improper switching sequence during a switching procedure caused bus 1-5 to trip, which eventually led to a reactor trip due to a low S/G level and feedflow/steamflow mismatch. The procedure was corrected and tested satisfactorily.

LER 78-36

During normal power operation containment pressure exceeded the Limiting Conditions for Operation, as specified in the Technical Specifications. The containment pressure rise is probably due to an air leak which will be identified and repaired during the next refueling shutdown.

LER 78-37

During surveillance testing at full power, one of two reactor trip breakers would not trip. The problem was traced to a shaft on the under voltage relay which was sticking and preventing the breaker trip. The shaft was cleaned and lubricated and the breaker was tested and re-turned to service.

5.0 FUEL INSPECTION REPORT

During Refueling #3, forty (40) fresh Region F assemblies were loaded for Cycle IV. Start-up physics testing was performed and the results reported in the Cycle IV Physics Report.

The irradiated fuel inspection was performed with an underwater TV camera. All peripheral fuel rods were examined using one-half face scans. Special corner scans were performed where the potential for baffle jetting failure existed. Seven assemblies were inspected. The three Region C assemblies were the first to experience three cycles of duty and relatively high burnup. Two Region D and two Region E assemblies were chosen to give a representative sample of two (2) assemblies per region. Two of these assemblies had been inspected previously for baffle jetting failure. The results again confirm the fact that core baffle jetting failure is not occurring at Kewaunee. The Region C fuel tends to exhibit fuel rod bowing with minor to significant reductions in the rod to rod gap. Numerous fuel rods are touching the bottom nozzle on Regions C and D fuel. Permanent deformation of the hold down springs was noted on Regions C and D fuel. An axial variation of oxide crud deposits was observed on most assemblies. A "bamboo" effect was observed on the fuel rods of several assemblies. Overall condition of the fuel was excellent with no evidence of fuel cladding degradation on the peripheral fuel rods examined. Complete video tapes were made of all examinations.

6.0 PERSONNEL EXPOSURE AND MONITORING REPORT

Pursuant to sections 407(b)(1)(i) and 407(b)(2) of 10 CFR 20, the following tabulation of the number of individuals receiving exposures within specified ranges and the total number of personnel for whom monitoring was provided is shown on the attached table.

1978

PLANT STAFF & VISITORS

Exp. Range	# Personnel
No Measurable	158
< 100	105
100-250	61
250-500	65
500-750	38
750-1K	25
1K-2K	36
2-3K	4
3-4K	0
4-5K	1
Grand Total	493

REPORT OF OCCUPATIONAL EXPOSURE DATA

The following tabulation of numbers of personnel exposures and man-rem received by work and job function is shown on the attached table in accordance with section 6.9.1.b. of the Kewaunee Nuclear Power Plant Technical Specifications.

U.S.N.R.C. REGULATORY GUIDE 1.16 - REPORTING OF OPERATING INFORMATION

Standard Format for reporting number of personnel and Man-Rem by work and job function-Year of 1973-Kewaunee

Work and Job Function	Number of Personnel (> 100 mrem)			Total Man-Rem		
	Station Employees	Utility Employees	Contract Workers & Others	Station Employees	Utility Employees	Contract Workers & Others
REACTOR OPERATIONS & SURVEILLANCE						
Maintenance Personnel	0	0	0	.000	.000	.000
Operating Personnel	10	0	0	5.753	.000	.274
Health Physics Personnel	0	0	0	.000	.000	.000
Supervisory Personnel	5	1	0	3.907	.215	.135
Engineering Personnel	1	0	0	.455	.000	.011
ROUTINE MAINTENANCE						
Maintenance Personnel	21	3	11	4.810	1.130	6.568
Operating Personnel	2	0	0	.627	.000	.000
Health Physics Personnel	5	0	12	2.512	.000	4.951
Supervisory Personnel	0	0	0	.052	.000	.000
Engineering Personnel	0	0	0	.000	.000	.000
INSERVICE INSPECTION						
Maintenance Personnel	0	2	26	.030	.562	12.803
Operating Personnel	3	0	0	.919	.000	.000
Health Physics Personnel	1	0	0	.350	.000	.000
Supervisory Personnel	1	0	1	.134	.013	.165
Engineering Personnel	0	1	2	.000	.188	1.455
SPECIAL MAINTENANCE						
Maintenance Personnel	25	12	82	9.546	2.884	36.030
Operating Personnel	3	0	0	.448	.055	.000
Health Physics Personnal	6	0	0	2.056	.000	.000
Supervisory Personnel	1	0	0	.458	.047	.010
Engineering Personnel	0	1	1	.023	.212	.302
WASTE PROCESSING						
Maintenance Personnel	10	0	7	2.327	.080	2.473
Operating Personnel	10	0	0	6.157	.000	.000
Health Physics Personnal	6	0	0	4.857	.000	.000
Supervisory Personnel	1	0	0	1.561	.000	.000
Engineering Personnel	0	0	0	.000	.000	.000
REFUELING						
Maintenance Personnel	8	8	19	3.268	3.012	18.751
Operating Personnel	1	0	0	.270	.000	.000
Health Physics Personnel	2	0	0	.513	.000	.000
Supervisory Personnel	2	0	1	1.032	.000	.766
Engineering Personnel	1	0	1	.838	.043	.171
TOTAL						
Maintenance Personnel	64	25	145	19.981	7.668	76.625
Operating Personnel	29	0	0	14.174	.055	.274
Health Physics Personnel	20	0	12	10.288	.000	4.951
Supervisory Personnel	10	1	2	7.144	.275	1.126
Engineering Personnel	2	2	4	1.316	.443	1.939
GRAND TOTAL	125	28	163	52.903	8.441	84.915

7.0 ENVIRONMENTAL TECHNICAL SPECIFICATIONS

(APPENDIX B)

This section employs the subsection numbering consistent with the specific subject covered in Appendix B.

2.1 Thermal

2.1.1 Maximum ΔT Across the Condenser

During normal operation of the plant, the ΔT (^oF) across the condenser was recorded hourly. The monthly averages and maximums are as follows:

	ΔT (Ave)	ΔT High Day (Ave)	ΔT Maximum Recorded	ΔT Max. Daily (Ave)
Jan	19.6	24.0	26.5	21.8
Feb	19.6	23.8	25.5	22.1
Mar	17.0	24.7	25.7	19.5
Apr	14.5	15.3	15.8	15.1
May	8.4	11.9	12.3	9.8
Jun	12.4	14.5	15.2	13.4
Jul	15.4	16.6	17.3	16.2
Aug	16.9	18.1	18.4	17.4
Sep	17.1	18.1	18.9	18.0
Oct	15.3	15.7	16.8	15.8
Nov	14.4	16.4	24.7	15.8
Dec	18.1	23.5	25.7	21.4

2.12 Maximum Discharge Temperatures

The maximum discharge temperature and the average of the maximum temperatures was:

	Discharge Temp. (Max) ^oF	Discharge Temp. (Ave Max) ^oF
Jan	64.6	58.1
Feb	66.6	59.1
Mar	65.7	60.4
Apr	65.5	60.0
May	63.9	59.1
Jun	69.9	64.5
Jul	73.5	69.5
Aug	85.2	72.5
Sep	85.3	82.5
Oct	71.4	68.3
Nov	69.0	62.8
Dec	67.0	60.4

2.1.3 <u>Rate of Temperature Change of Condenser Cooling Water, T</u>

During normal power operation, the rate of change of condenser cooling water temperature did not exceed 15°F during normal power increase and 8°F during normal power decrease.

2.2 Chemicals

2.2.1 Chlorination of the Circulating Water System

The circulating water system has not been chlorinated during this period of reporting.

2.2.2 Suspended and Dissolved Solids

The neutralizing tank has been discharging to the lagoon.

2.2.3 Treatment Chemicals

The total amount of raw chemicals used during the calendar year was as follows:

	Totals
1. Primary System	
a. Boric Acid	1,300 lbs.
b. Hydrazine	4.23 gal.
c. Lithium7 Hydroxide	0 lbs.
2. Secondary Treatment Chemicals	
a. Hydrazine	418.11 gal.
3. Pre-Treatment System Chemicals	
a. Ferric Sulfate	13,150 lbs.
b. Lime	0 lbs.
c. Polyelectrolyte	179.84 lbs.
d. Sodium Hypochlorite (15%)	1,683 gal.
e. Sodium Sulfite	992.5 lbs.
4. Demineralizer System	
a. Sodium Hydroxide 50 w/o	437,760 lbs.
b. Sulphuric Acid	366,300 lbs.
5. Potable Water Softeners	
a. Salt (NaCl)	22,850 lbs.
6. Circulating Water System	
a. Sodium Hypochlorite	0 gal.
7. Component Cooling System	
a. Chromates	0 lbs.

2.2.4 Miscellaneous Discharge

The pH and total suspended solids before dilution of the condenser hotwell, turbine building sump, water softening unit and pretreatment system lagoon are characterized as follows:

1. Condenser Hotwell

	pH			Suspended Solids mg/L			Total	
	High	Low	Ave	High	Low	Ave	SS Lbs.	Gallons
Jan	--	--	--	--	--	--	--	--
Feb	--	--	--	--	--	--	--	--
Mar	--	--	--	--	--	--	--	--
Apr	8.6	8.6	8.6	6.1	6.1	6.1	3.81	75,000
May	7.6	6.6	7.1	29.2	3.8	16.5	7.02	58,187
Jun	8.8	8.6	8.7	1.1	0.9	1.0	.63	72,187
Jul	--	--	--	--	--	--	--	--
Aug	--	--	--	--	--	--	--	--
Sep	--	--	--	--	--	--	--	--
Oct	--	--	--	--	--	--	--	--
Nov	8.85	8.85	8.85	0.5	0.5	0.5	.14	33,750
Dec	--	--	--	--	--	--	--	--

2. Turbine Building Sumps

	pH			Suspended Solids mg/L			Total	
	High	Low	Ave	High	Low	Ave	SS Lbs.	Gallons
Jan	8.5	6.2	7.79	26.4	1.2	6.50	83.50	1,523,490
Feb	8.5	7.6	8.07	27.0	1.5	6.29	76.22	1,403,130
Mar	8.3	7.4	7.85	12.4	1.1	6.63	82.68	1,465,830
Apr	8.3	7.4	7.74	68	1.7	10.19	130.39	1,459,530
May	7.9	7.0	7.53	10.4	1.1	3.86	40.99	1,295,240
Jun	8.3	7.0	7.78	6.5	1.5	2.96	32.95	1,334,440
Jul	8.2	3.3*	7.49	15.3	0.90	3.20	26.35	1,000,470
Aug	7.95	3.5**	7.14	18.0	1.4	5.10	58.44	1,296,160
Sep	7.9	7.1	7.51	24.8	1.0	7.72	71.40	979,770
Oct	8.42	3.5	7.67	48.5	0.40	9.51	78.04	967,850
Nov	8.5	3.3	7.67	30.3	1.3	5.82	37.29	767,070
Dec	8.6	7.0	7.67	25.0	0.5	7.78	36.82	570,080

* See S.P. Exception Report - Reported to T.P.M. by phone - Incident report not required on WPDES cases (7/18/78) 7/19/78 Ed Newman will report to DNR.

**See S.P. Exception Report dated 8/30/78.

3. Water Softening Unit

	pH			Suspended Solids mg/L			Total	
	High	Low	Ave	High	Low	Ave	SS Lbs.	Gallons
Jan	7.4	7.4	7.4	3.1	3.1	3.1	0.06	2,400
Feb	7.5	7.6	7.55	6.7	5.7	6.2	0.25	4,800
Mar	7.3	7.3	7.3	18.0	17.0	17.5	0.70	4,800
Apr	7.6	7.0	7.27	21.1	7.3	15.67	1.88	14,400
May	7.4	7.1	7.28	21.8	14.8	17.61	2.82	19,200
Jun	7.1	6.9	7.0	14.0	3.7	8.85	0.35	4,800
Jul	7.5	7.5	7.5	12.1	12.1	12.1	0.24	2,400
Aug	7.3	6.9	7.1	56	29.4	42.7	1.71	4,800
Sep*	7.9	7.9	7.9	27	9.7	18.35	0.73	4,800
Oct	7.7	7.2	7.45	12	10.8	11.4	0.46	4,800
Nov	7.6	7.5	7.55	19.4	11.9	15.65	0.63	4,800
Dec	7.4	7.3	7.35	15.9	10.0	12.95	0.52	4,800

*pH on discharge of 9/22 not analyzed.

4. Pretreatment System Lagoon

	pH			Suspended Solids mg/L			Total	
	High	Low	Ave	High	Low	Ave	SS Lbs.	Gallons
Jan	7.8	6.6	7.55	14.0	2.0	5.00	53.52	1,289,497
Feb	7.7	7.4	7.55	6.0	1.0	2.80	23.20	1,177,523
Mar	7.7	7.3	7.56	6.9	1.5	3.42	38.84	1,336,545
Apr	8.1	7.3	7.61	20.1	1.3	8.40	94.95	1,297,310
May	7.9	7.1	7.54	14.2	1.3	5.37	50.77	1,041,795
Jun	7.8	7.5	7.58	3.8	1.5	2.28	24.55	1,282,329
Jul	7.9	7.5	7.60	8.2	1.0	2.39	24.72	1,266,826
Aug	8.3	7.1	7.62	20.7	1.6	4.71	51.69	1,749,331
Sep	7.82	7.52	7.67	18.7	1.0	3.80	34.76	1,072,108
Oct	7.97	7.54	7.74	1.6	0.1	0.79	7.86	1,189,148
Nov	8.0	7.5	7.73	51.6	0.2	2.87	25.02	1,089,690
Dec	7.7	6.4	7.36	42.9	0.4	5.88	61.95	1,202,976

4.0 Environmental Surveillance & Special Studies

4.1 Biological

4.1.1 Aquatic

1. Fish Impingement

Fish impingement data is listed on Table 1 (3 pages).

4.2.2 De-Icing Operation

Operation of the de-icing pump during the reporting period.

			Inlet Temperature °F	
Date	On	Off	Maximum	Minimum
1-1 to 2-28	00:00	04:45	48.1	31.9

Table 3

FISH IMPINGEMENT DATA

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alewife - Alosa pseudoharengus												
Number	172	0	6	34	7,590	21,850	11,076	2,795	697	2,950	987	22
Size - cm	7-20		17	14-19	17-21	5-23	8-21	10-20	10-20	4-19	6-18	7-19
Wgt-Kg	4.5		.2	1.1	270	720	420.3	113.7	23	82.9	19.8	.66
Smelt - Osmerus mordax												
Number	616	182	880	3,440	800	95	140	1,771	0	2,440	2,369	114
Size - cm	10-20	8-20	10-21	10-21	12-22	10-22	10-16	8-20		5-19	5-22	10-18
Wgt.-Kg	21.8	4.7	32.5	135.6	28.3	1.7	1.8	35.7		45.9	46.1	3.0
White Sucker - Catostomus commersonni												
Number	81	56	112	90	135	70	39	10	116	50	3	0
Size - cm	23-50	24-37	24-47	26-52	23-46	20-52	36-43	36-43	17-49	19-40	26	
Wgt-Kg	49.7	27.8	69.2	61.7	87.5	51	24.3	5.4	66.6	14.3	.6	
Longnose Sucker Catostomus catostomus												
Number	31	14	56	64	70	45	109	24	125	60	46	31
Size - cm	28-42	27-33	22-33	27-41	19-44	32-46	31-46	33-46	19-46	10-43	12-49	32-47
Wgt-Kg	14.9	5.5	20.5	27	30.5	30.6	54	10.8	38.4	13.9	13.8	19.4
Yellow Perch - Perca flavescens												
Number	0	0	0	7	90	0	23	17	13	0	7	0
Size - cm				24-31	12-31		26-27	23-30	16-29		20-23	
Wgt-Kg				4.4	21.9		6.0	6.7	4.6		.99	
Longnose Dace - Rhinichthys cataractae												
Number	0	0	0	26	10	40	226	112	916	0	0	0
Size - cm				10-14	11-12	7-14	6-13	9-12	8-14			
Wgt-Kg				.38	.12	.5	2.7	1.4	9.2			

Table 3

FISH IMPINGEMENT DATA

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bullhead - *Ictalurus spp.*												
Number	8	5	12	26	35	0	31	10	9	85	40	31
Size - cm	21-33	28	21-23	14-21	15-22		18-26	17-23	16-21	14-28	16-25	14-25
Wgt-Kg	1.6	.80	2.05	2.5	4.1		4.5	1.4	1.2	11.7	6.8	5.6
Carp - *Cyprinus carpio*												
Number	16	14	31	13	20	10	8	3	0	5	13	26
Size - cm	54-71	54-78	36-62	40-61	41-94	61-71	74	64		48	53-61	30-72
Wgt-Kg	67	33.8	71.3	30.3	68.2	41.5	21.8	7.7		5.7	22.4	76.1
Slimy Sculpin - *Cottus cognatus*												
Number	130	84	332	378	170	375	367	286	791	895	333	378
Size - cm	5-14	6-7	5-9	5-10	5-11	5-9	6-9	5-10	5-10	4-9	4-10	4-9
Wgt-Kg	.4	.20	.75	.9	.47	1.3	1.4	1.3	2.0	6.3	1.5	1.9
Lake Trout - *Salvelinus namaycush*												
Number	27	14	0	9	5	10	16	17	34	25	53	18
Size - cm	19-60	26-57		61-63	40	53-63	72-80	53-81	32-79	11-20	16-57	20-67
Wgt-Kg	7.7	7.3		20.4	6.5	18.9	68.5	.06	84.5	1.0	53.0	25.3
Brown Trout *Salmo trutta*												
Number	4	0	0	0	0	20	0	0	17	15	20	141
Size - cm	36					30-38			36-51	16-63	22-51	14-52
Wgt-Kg	.8					11.5			19.5	6.0	18.75	43.7
Rainbow Trout *Salmo gairdnerii*												
Number	0	0	12	0	0	0	0	0	0	0	0	0
Size - cm			12-26									
Wgt-Kg			2.2									

Table 3

FISH IMPINGEMENT DATA

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shorthead Redhorse <u>Moxostoma macrolepidotum</u>												
Number	0	0	6	0	5	0	0	0	0	0	0	0
Size - cm			33		35							
Wgt-Kg			3.9		3.9							
Lake Chub - <u>Hybopsis plumbea</u>												
Number	0	0	0	4	0	0	0	0	0	0	0	0
Size - cm				15								
Wgt-Kg				.2								
Lake Whitefish - <u>Coregonus clupeaformis</u>												
Number	12	9	6	17	0	5	8	7	22	0	23	4
Size - cm	33-34	30-32	31	30-51		54	56	36-50	29-46		15-31	43
Wgt-Kg	3.9	4.6	2.6	15.3		21.0	15.3	5.1	18.6		2.9	2.9
Coho - <u>Oncorhynchus kisutch</u>												
Number	4	0	0	0	0	0	0	0	0	0	26	0
Size - cm	36	0	0	0	0	0	0	0	0	0	45-79	0
Wgt-Kg	2.4										72.4	
Chinook - <u>Oncorhynchus tshawytscha</u>												
Number	0	0	0	0	0	0	0	0	0	5	36	0
Size - cm										59	53-65	
Wgt-Kg										13.0	99.5	
Burbot - <u>Lota lota</u>												
Number	4	0	6	0	0	0	0	7	0	0	0	0
Size - cm	37		105					53-59				
Wgt-Kg	.12		13.8					25.1				

8.0 RADIOLOGICAL MONITORING PROGRAM

Attached is the report from Hazelton Environmental Sciences Corporation on the Radiological Monitoring Program for the Kewaunee Nuclear Power Plant for 1978.

HAZLETON
ENVIRONMENTAL SCIENCES CORPORATION
1500 FRONTAGE ROAD, NORTHBROOK, ILLINOIS 60062, U.S.A.

REPORT TO

WISCONSIN PUBLIC SERVICE CORPORATION
WISCONSIN POWER AND LIGHT COMPANY
MADISON GAS AND ELECTRIC COMPANY

RADIOLOGICAL MONITORING PROGRAM FOR THE KEWAUNEE NUCLEAR POWER PLANT KEWAUNEE, WISCONSIN

ANNUAL REPORT - PART I
SUMMARY AND INTERPRETATION
January - December 1978
Hazleton No. 5501-08783/08937

PREPARED AND SUBMITTED
BY
HAZLETON ENVIRONMENTAL SCIENCES CORPORATION

Report approved by: [signature]
G. W. Wadley, Ph.D.
Scientific Director

22 February 1979

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PREFACE

The staff members of the Nuclear Sciences Section of Hazleton Environmental Sciences were responsible for the acquisition of data presented in this report. Assistance in sample collections was provided by the Field Operations Section of Hazleton Environmental Sciences and by Wisconsin Public Service Corporation personnel.

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

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I. Introduction

The Kewaunee Nuclear Power Plant is a 540 megawatt pressurized water reactor located on the Wisconsin shore of Lake Michigan in Kewaunee County. The Kewaunee Nuclear Power Plant went critical on March 7, 1974. Initial power generation was achieved on April 8, 1974, and the Plant was declared commercial on June 16, 1974. This report summarizes the environmental operational data collected during the period January - December 1978.

Wisconsin Public Service Corporation, as operating company for the Kewaunee Nuclear Power Plant, assumes the responsibility for the environmental programs at the Plant and any questions relating to this subject should be directed to them.

II. Summary

Results of sample analyses during the period January-December 1978 are summarized in Table 5. Radionuclide concentrations measured at indicator locations are compared with levels measured at control locations and in pre-operational studies. The comparisons indicate background-level radioactivities in all samples collected with the following exceptions:

(1) One surface water sample collected at the discharge (K-1d) on 5 January 1978 and one sample collected at K-14 on 1 January 1978 had tritium levels about 1030 pCi/l and 6420 pCi/l above the background level of 210 pCi/l. The elevated level in the sample collected at the discharge is attributable to the Kewaunee Nuclear Plant operation, but constitutes only about 0.03% of the maximum permissible concentration of 3,000,000 pCi/l established in 10 CFR 20 Document. The source of the elevated level in the sample collected at K-14 is not clear, since this location is equidistant from the Kewaunee and Point Beach Nuclear Plants, either one of which, or both, could have been the source of the elevated tritium level.

(2) Trace amounts of activation products, cobalt-58 and cobalt-60, detected in slime sample collected at the discharge could be attributed to the plant operation.

(3) Trace amounts of cobalt-58, cobalt-60, and cesium-134 detected in bottom sediment samples collected near the condenser discharge could be attributed to the plant operation.

In addition, 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 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 Wisconsin 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.

III. Methodology

The sampling locations are shown in Figure 1. Table 1 describes the locations, lists for each its direction and distance from the reactor, 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 sample 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 year is discussed.

A. The Air Program

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 six locations (K-1f, K-2, K-7, K-8, K-15, and K-16), and dispatched by mail to Hazleton Environmental Sciences for radiometric analysis. The material on the filter is counted for gross alpha and beta activity approximately five days after receipt to allow for decay of naturally-occurring short-lived radionuclides.

Quarterly composites from each sampling station are analyzed for gamma-emitting isotopes by germanium-lithium spectroscopy.

The integrated gamma-ray background is measured at air sampling locations (K-1f, K-2, K-7, K-8, K-15, and K-16) and at four milk sampling locations (K-3 through K-6) with ion chambers and thermoluminescent dosimeters (TLD's). Ion chambers are placed in duplicate and read monthly. Lithium flouride TLD's are exchanged quarterly and annually.

Charcoal filters are located at Stations K-1f, K-2, K-7, K-8, K-15, and K-16. The filters are changed bi-weekly and analyzed for iodine-131 immediately after arrival at the laboratory.

Monthly composites of precipitation samples collected at K-11 are analyzed for tritium activity by liquid scintillation techniques.

B. The Terrestrial Program

Milk samples are collected weekly (one gallon from each location) from May through October and monthly (two gallons from each location) during the rest of the year from four herds that graze within four miles of the reactor site (K-4, K-5, K-12, and K-19) and from two herds that graze between four and ten miles from the reactor site (K-3 and K-6). The milk samples are analyzed for iodine-131, strontium-89 and -90, cesium-137, barium-140, potassium-40, calcium, and stable potassium.

One-gallon water samples are collected quarterly from four off-site wells located at K-10, K-11, K-12, and K-13. Monthly one-gallon water samples are collected from two on-site wells located at K-1g and K-1h.

The gross alpha and beta activities are determined on the total residue of each water sample. The concentration of potassium-40 is calculated from total potassium, which is determined by flame photometry on all samples. The tritium levels in quarterly composites of monthly on-site samples from K-1g are determined by liquid scintillation techniques.

Quarterly composites of monthly grab samples of water from one on-site well (K-1g) are analyzed for strontium-89 and strontium-90.

Domestic meat samples (chickens) are obtained annually (in the third quarter) at Locations K-17, K-20, K-22, and K-24). The flesh is separated from the bones, ashed, and analyzed for gross alpha and gross beta activities and gamma scanned.

Eggs are collected quarterly at Location K-17. The samples are gamma scanned and analyzed for gross alpha, gross beta, strontium-89, and strontium-90 activities.

Vegetable samples (5 varieties) are collected at Location K-18 and two varieties of grain at Location K-23. The samples are gamma scanned and analyzed for gross alpha, gross beta, strontium-89, and strontium-90 activities.

Grass samples are collected during the second, third and fourth quarters from two on-site locations (K-1b and K-1f) and from six dairy farms (K-3, K-4, K-5, K-6, K-12, and K-19). The samples are gamma scanned and analyzed for gross alpha, gross beta, strontium-89, and strontium-90 activities. During the first quarter cattle feed is collected from the same six dairy farms, and the same analyses are performed.

Soil samples are collected twice a year on-site at K-1f and from the six dairy farms (K-3, K-4, K-5, K-6, K-12, and K-19). The samples are gamma scanned and analyzed for gross alpha and gross beta, strontium-89, and strontium-90 activities.

C. The Aquatic Program

One-gallon water samples are taken monthly from three locations on Lake Michigan: 1) at the point where the condenser water is discharged into Lake Michigan (K-1d); 2) at Two Creeks Park (K-14) located 2.5 miles south of the reactor site; and 3) at the Rostok water intake (K-9) located 11.5 miles north of the reactor site. Additionally, one-gallon water samples are taken monthly from three creeks that pass through the site (K-1a, K-1b, and K-1e). Samples from North and Middle Creeks (K-1a and K-1b) are collected near the mouth of each creek. Samples from the South Creek (K-1e) are collected about ten feet downstream from the point where the outflows from the two drain pipes meet.

The water samples are analyzed for gross alpha and gross beta activity in the total residue, dissolved solids, and suspended solids. The concentration of potassium-40 is calculated from total potassium, which is determined by flame photometry. The tritium activity of the Lake Michigan samples is determined by liquid scintillation techniques. Quarterly composites of monthly grab samples from Lake Michigan are also analyzed for strontium-89 and strontium-90.

Fish samples (2 species) are collected in the second, third, and fourth quarters at Location K-1d. The flesh is separated from the bones, ashed, analyzed for gross alpha and gross beta activity, and gamma scanned. Ashed bone samples are analyzed for gross alpha, gross beta, strontium-89 and strontium-90 activities.

Bottom organisms are collected in the second, third and fourth quarters from the discharge canal area (K-1d), Rostok water intake (K-9), and Two Creeks Park (K-14). Samples are analyzed for gross alpha and gross beta activities and are also gamma scanned if available in sufficient quantity.

Slime samples are collected during the second and third quarters from three Lake Michigan locations (K-1d, K-9, and K-14), from three creek stations (K-1a, K-1b, and K-1e), if available. The samples are analyzed for gross alpha and gross beta. If the quantity is sufficient, they are also gamma scanned and analyzed for strontium-89 and strontium-90 activities.

Bottom sediments are collected four times a year from five locations (K-1c, K-1d, K-1j, K-9, and K-14). The samples are analyzed for gross alpha and gross beta activities and for stronitum-89 and strontium-90. Each sample is also gamma scanned. Since it is known that the measured radioactivity per unit mass of sediment increases with decreasing particle size, the sampling procedure is designed to assure collection of very fine particles.

D. 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 data for locations K-1f, K-2, K-7, K-8, and K-15 for the collection period ending 10-04-78 because the wrong type of filter was installed.

(2) There were no air particulate and iodine-131 data for location K-7 for the collection period ending 4-26-78 because of the pump malfunction.

(3) There were no air particulate data for location K-7 for the collection period ending 12-21-78 because meter was not functioning properly.

(4) There were no air particulate data for location K-8 for the collection periods ending 1-18-78 and 2-15-78 because of vandalism of the pumps.

(5) There were no air particulate data for location K-15 for the collection period ending 7-12-78 because the fuse was blown.

(6) There was no iodine-131 datum for location K-16 because the sample was lost in transit.

(7) No ion chamber data was available for location K-4 (January) and K-3 (October and December) because both chambers read full scale.

(8) One of the two ion chambers at locations K-16 (January), K-4 (April), K-6 (May), K-6 (July), K-7 (July), K-16 (July),

and K-1f (December), could not be read because the chambers read full scale.

(9) No ion chamber data was available for locations K-1f, K-2, K-3, K-4, K-5, K-6, K-7, K-8, K-15, and K-16 for February because of the malfunction of the minometer used to read the chambers on 1 March 1978.

(10) No ion chamber data was available for locations K-1f, K-2, K-3, K-4, K-5, K-6, K-7, K-8, K-15, and K-16 for March because the chambers were not charged properly due to malfunction of the minometer on 1 March 1978.

(11) No ion chamber data was available for locations K-4, K-5, K-6, K-7, and K-8 for October because both chambers readings were very low and considered unreliable.

(12) There was no annual TLD datum available for location K-1f because the packet containing TLD's was lost during the sampling trip.

(13) Water was not available at location K-10 during the first quarter. The sample was substituted from the nearest farm (K-19).

(14) Chickens were not available from George Struck farm (K-20) because the farmer no longer raises chickens. The sample was collected from the adjacent Carl Struck farm (K-20).

(15) Chickens were not available from Bill Hardtke farm (K-21) because the farmer no longer raises chickens. The sample was collected from a new location, Fectum farm (K-24).

(16) No buckwheat was collected at location K-23 because

it was not grown there in 1978.

(17) No surface water sample could be collected in March from the North Creek (K-1a) because it was frozen.

(18) On 1-05-78, 2-01-78, and 3-01-78 no surface water could be collected from the South Creek (K-1e) because it was frozen. Substitute samples were taken from Sewage Treatment Pond No. 1.

(19) No gamma-spectroscopic data could be obtained on all nine bottom organism samples because the samples were of insufficient size for analyses.

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 will be discussed in the order listed in Table 4. Any references to previous environmental data for the Kewaunee Nuclear Power Plant refer to data collected by NALCO Environmental Sciences or Industrial BIO-TEST Laboratories, Inc.

The tabulated results of all measurements made in 1978 are not included in this section, although references to these results will be made in the discussion. The complete tabulation of the 1978 results is contained in Part II of the 1978 annual report on the Radiological Monitoring Program for the Kewaunee Nuclear Power Plant.

A. The Air Environment

For air particulates, both gross alpha and gross beta measurements yielded annual means that were slightly higher at the four control locations than at the two indicator locations. The location with the highest annual mean was the control location K-16, 26 miles NW of the plant.

Gross alpha and beta activities at all locations were also analyzed by months and quarters. While alpha activity exhibited no definite trend, the highest gross beta averages were for the month of March and the first and second quarters. Air particulates collected on 3-29-78, fifteen days after the Chinese nuclear test, were the highest for any week recorded and were by about a factor of 5 higher than the average for the previous twelve weeks of the first quarter.

Activities remained elevated throughout the second quarter and then dropped below pre-March nuclear test levels. The March peak and elevated levels for the first and second quarters were 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).

Gamma-spectroscopic analysis of quarterly composites of air particulate filters yielded identical results for beryllium-7 (0.052 pCi/m^3) which is produced continuously in the upper atmosphere by cosmic-ray interaction (Arnold and Al-Salih, 1955).

Small amounts of the fallout product, cerium-144, were detected at both indicator and control locations. All other gamma-emitting isotopes were below their detection limits.

Bi-monthly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.01 pCi/m^3 at all locations. Thus, there is no indication of an effect of the plant on the local air environment.

Ambient gamma radiation was monitored by ion chambers and TLD's at ten locations, four indicator and six control.

For the ion chambers at the indicator locations, the radiation exposure averaged 6.4±0.8[1/] mR/(30 days) while for the control locations it was 6.8±1.0 mR/(30 days). In both cases, the range was approximately ±50% of the mean. The two means may be considered to be in agreement since their difference is smaller than the sum of their estimated uncertainties. The location with the highest annual mean (7.7±0.4) was the control location K-8, 5 miles WSW of the plant. Since this location is so distant from the plant and since it typically yielded the highest monthly ion-chamber readings during the 1973 pre-operational study, the high result is not attributable to the plant.

The quarterly TLD's at the indicator locations measured a mean dose equivalent to 52.2±6.1 mrem/(365 days), in agreement

1/ Unless otherwise indicated, uncertainties of average values are standard deviations of the individual measurements over the period averaged. Uncertainties of individual measurements represent probable counting error at the 95% confidence level.

with the mean at the control locations of 61.6±9.9 mrem/(365 days) and were similar to the means obtained in 1977 (52.3 and 59.2 mrem/(365 days), respectively). The quarterly measurements agreed with the annual measurements which were 55.0±10.8 mrem(365 days) for both indicator and control locations. The mean annual dose equivalent for all locations was 56.0 mrem/(365 days) and was nearly identical to the dose obtained in 1977 (56.7 mrem/365 days). All of these values are about 30% lower than the United States average value of 78 mrem/year due to natural background radiation (National Council on Radiation Protection and Measurements, 1975). The highest means for the quarterly and annual TLD's were nearly identical (72.3 and 72.7 mrem/(365 days) and occured at the control locations K-16 and K-8, respectively.

Precipitation was monitored only at an indicator location, K-11. The tritium level ranged from 165 to 448 pCi/l and averaged 295 pCi/l. The range is similar to that found in the 1973 pre-operational study and is therefore not attributed to plant operation.

B. The Terrestrial Environment

Of the 192 analyses for iodine-131 in milk all were below the LLD level of 0.5 pCi/l, except for one measurement on the sample collected on 4 April 1979 from control location K-6. The activity detected was 0.7±0.2 pCi/l, barely above the LLD level, and was attributable to fallout from the 14 March 1978 Chinese nuclear test.

Strontium-89 activity was detected in trace amounts in twelve samples, ten of which were in January and February. The other two samples were collected in April and July. The mean values were essentially identical for indicator and control locations. Because the half-life of strontium-89 is 51 days, the September 1977 and March 1978 atmospheric tests are the most probable source for its presence in these samples. An increase in strontium-89 levels unaccompanied by any increase in strontium-90 levels is understandable on the basis of yield curves for nuclear weapons. Ten days after explosion of a nuclear weapon, strontium-89 activity exceeds strontium-90 activity by a factor of more than 100. Strontium-89 activity continues to exceed strontium-90 activity until nearly a year has passed (Eisenbud, 1963).

Strontium-90 activity was found in all samples. The mean values were essentially identical for all indicator and control locations.

Barium-140 activity was below the LLD of 3.7 pCi/l in all samples.

Potassium-40 and cesium-137 results averaged slightly higher at the control than at the indicator locations and were essentially identical to the levels observed in 1977. None of the differences among the means are statistically significant.

Due to the chemical similarities between strontium and calcium, and cesium and potassium, organisms tend to deposit cesium-137 in the soft tissue and muscle and strontium-89 and -90 in the bones. Consequently, the ratios of strontium-90 activity to the weight of calcium in milk and cesium-137 activity to the weight of potassium in milk were monitored in order to detect potential environmental accumulation of these radionuclides. No statistically significant variations in the ratios were observed. The measured concentrations of stable potassium and calcium are in agreement with previously determined values of 1.50±0.21 g/l and 1.16±0.08 g/l, respectively (National Center for Radiological Health 1968).

Except in three samples, all measurements for gross alpha activity in well water were below the LLD of 4.0 pCi/l. Analysis for radium-226 in samples with levels above the LLD of 4.0 pCi/l yielded less than 1.0 pCi/l of radium-226 for all samples.

Gross beta activity was below the LLD of 2.2 pCi/l in samples from control locations. The mean value from all indicator locations was 3.4 pCi/l and was nearly identical to the values observed in 1977 (3.3 pCi/l).

Tritium activity in the on-site well (K-1g) was determined by electrolytic enrichment and scintillation counting and was below the LLD of 40 pCi/l in all samples.

The activities of strontium-89 and strontium-90 in well water were below detection limits.

Potassium-40 levels were quite low (under 3.0 pCi/l) in agreement with the previously measured values.

In meat samples (chickens) gross alpha activities were 0.08 pCi/g wet weight and 0.09 pCi/g wet weight for indicator and control locations, respectively. Gross beta activities averaged 1.85 pCi/g wet weight for indicator locations and 2.8 pCi/g wet weight at the control location. Gamma-spectroscopic analysis showed that most of the beta activity was due to naturally occuring potassium-40. The cesium-137 level was below the LLD of 0.01 pCi/g wet weight in all samples.

In egg samples, the gross alpha activity was below the LLD of 0.06 pCi/g wet weight in all samples. Gross beta activities averaged approximately 1 pCi/g wet weight, about equal to the activity of the naturally occuring potassium-40 observed in the samples. The levels of strontium-89, strontium-90, and cesium-137 were below their LLD's.

In vegetables, alpha activities were below the LLD of 0.07 pCi/g wet weight in all but one sample. The detected alpha activity was 0.08 pCi/g wet weight. Gross beta activity was slightly higher at the indicator location than at the control location and was due primarily to the potassium-40 activity. Strontium-89 activity was below the LLD of 0.002 pCi/g wet weight in all samples. Strontium-90 activity was slightly higher at the indicator location (0.024 pCi/g wet weight) than at the control location (0.008 pCi/g wet weight). Beryllium-7 activity was below the LLD of 0.056 pCi/g wet weight in all samples. A trace amount of fallout product cerium-144 was detected in one sample collected at the control location. All other gamma-emitting isotopes were below their LLD's. The sample of oats was of similar composition but the activity was slightly higher due to the lower water content of the grain in comparison with the vegetables.

In grass, alpha levels were only sporadically above the detection limit of 0.17 pCi/g wet weight. Gross beta activities were similar at indicator and control locations (8.1 and 9.0 pCi/g wet weight, respectively) and in both cases were predominantly due to naturally occuring potassium-40, beryllium-7 and to fallout products: niobium-95, cesium-137, and cerium-144. All other gamma-emitting isotopes were below their LLD's. In general, the fallout products in samples collected in June were higher than in samples collected in August and October and are attributable to the fallout from the March nuclear test. Strontium-89 activity, detected in two samples, was barely above the LLD 0f 0.02 pCi/g wet weight and was identical at both indicator and control locations (0.03 pCi/g wet weight). Strontium-90 activity was detected in all samples and was higher at control locations than at indicator locations (0.11 and 0.07 pCi/g wet weight, respectively). Presence of strontium-89 and -90 was due to fallout from previous and recent nuclear tests.

For cattlefeed, gross alpha activity was below the LLD of 0.3 pCi/g wet weight at all indicator locations and was at the LLD level in one sample from the control location K-6. Mean gross beta activity was higher at indicator locations (7.6 pCi/g wet weight) than at control locations (5.3 pCi/g wet weight). The highest gross beta level was in the sample from indicator location K-4

(16.8 pCi/g wet weight) and reflected the high potassium-40 level (13.7 pCi/g wet weight) observed in the sample.

Mean strontium-89 levels were nearly identical at both indicator and control locations (0.13 and 0.14 pCi/g wet weight, respectively). Strontium-90 activity was higher (0.08 pCi/g wet weight) at the indicator locations than at the control locations (0.04 pCi/g wet weight). The presence of the radiostrontium is attributable to the fallout from the previous and recent nuclear tests. Mean cesium-137 levels were identical at both indicator and control locations (0.05 pCi/g wet weight).

No significant differences were found between indicator and control values for soil samples. The difference of 2.4 pCi/g dry weight in mean gross alpha activity between indicator locations and control locations is not statistically significant because the counting uncertainties of the individual measurements are typically 3-4 pCi/g dry weight. Mean gross beta levels were identical at indicator and control locations (24.9 pCi/g dry weight). A trace amount of strontium-89 was detected in only one sample collected in June from control location K-3. Strontium-90 was detected in all samples and was higher at control locations (0.171 pCi/g dry weight) than at indicator locations (0.129 pCi/g dry weight).

In summary, terrestrial data for 1978 show no effects from the plant, but do exhibit some effect attributable to fallout from recent atmospheric nuclear tests.

C. The Aquatic Environment

In surface water, the mean gross alpha activity in suspended solids was slightly above the LLD of 0.4 pCi/l and was nearly identical at indicator and control locations (0.6 and 0.7 pCi/l, respectively). In dissolved solids gross alpha activity was below the LLD of 3.7 pCi/l at the control location and averaged 5.5 pCi/l at two indicator locations.

Mean gross beta activity in suspended solids was below the LLD of 0.6 pCi/l at the control location and was 1.4 pCi/l at indicator locations. Mean gross beta activity in dissolved solids was, by a factor of two, higher at indicator locations (5.4 pCi/l) in comparison to the control location (2.7 pCi/l). The control sample is the Lake Michigan water which varies very little in activity during the year, while indicator samples include two creek locations (k-la and K-le) which are much higher and exhibit large month-to-month variations in gross beta activities. The K-la creek drains its water from the surrounding fields which are heavily fertilized and K-le creek draws its water mainly from the Sewer Treatment Pond No. 1. In general, gross beta activity levels were high when potassium-40 levels were high and low when potassium-40 levels were low, indicating that the fluctuations in beta activity were due to variations in potassium-40 concentrations and not to plant operation. The fact that similar fluctuations at the locations were observed in the 1973 pre-operational study supports this assessment.

Annual mean tritium activity was about a factor of three higher at indicator locations in comparison to control location.

The elevated mean activity was due to higher activity in one sample collected at the discharge (K-1d) on 5 January 1978 (1240 pCi/l), and one sample collected at K-14 (6630 pCi/l), as compared to the 210 pCi/l level in Lake Michigan. The elevated tritium activity in the discharge water is attributable to the plant operation but constitutes less than 0.03% of the maximum permissible concentration of 3,000,000 pCi/l established in 10 CFR 20 Document. The source of elevated tritium level observed at K-14 is not clear. This location is about equidistant from both Kewaunee and Point Beach nuclear plants, either one of which could have been the source of the elevated tritium level.

Strontium-89 and -90 levels were below the LLD of 1.0 pCi/l in all samples.

In fish samples, gross alpha activity was below detection limits in both muscle and bones. In muscle, gross beta and potassium-40 levels were nearly identical. The average beta activity of 2.76 pCi/g wet weight was near the middle of the 1973 range of 2.26 to 3.62 pCi/g wet weight. The cesium-137 activity in muscle averaged 0.164 pCi/g wet weight. The strontium-89 level in bones was below the LLD, while strontium-90 averaged 0.31 pCi/g dry weight. This was near the lower limit of the 1973 range of 0.40 to 1.09 pCi/g dry weight.

Only small amounts of bottom organisms were collected resulting in rather high LLD's. Gross alpha and gross beta measurements at the control and indicator locations were below LLD's. The quantities of bottom organisms were of insufficient quantity for gamma spectral analysis.

In periphyton (slime) samples, strontium-89 levels were below the LLD of 0.29 pCi/g wet weight in all samples and levels of strontium-90 were below the LLD of 0.27 pCi/g wet weight in all but one sample. The detected activity, 0.422 pCi/g wet weight, was in the sample collected in August from K-1b creek. Mean values of gross beta and potassium-40 levels were higher at indicator locations. Contributing to the higher mean values at the indicator locations was one sample collected 6-05-78 from creek location K-1a. The drainage area of this creek includes fields which are heavily fertilized resulting in high potassium-40 levels and, therefore, in high gross beta. The gross alpha level was also higher in the samples collected at this location and at the creek location K-1e, which flows out of the sewer treatment pond. Gamma-spectroscopic analysis of the periphyton sample collected 8-01-78 from the discharge (K-1d) yielded trace-level amounts of the following man-made isotopes: cobalt-58, cobalt-60, niobium-95, zirconium-95, cesium-137, and cerium-144. Of these, niobium-95, zirconium-95, and cerium-144 were observed at the control location K-9. Trace amounts of cesium-137 were detected in several samples from creeks, K-10, K-1b, K-1e and K-14. Thus, the presence of trace amounts of cobalt-58 and cobalt-60 may be due to plant operation.

In bottom sediment samples, gross alpha levels were below the LLD of 5.0 pCi/g dry weight in all but two samples. The mean value of 6.0±1.3 pCi/g dry weight in the samples collected at K-1d and K-14 was not significantly different from the LLD because of the large counting error.

Mean gross beta levels were nearly identical at indicator and control locations and were due mostly to potassium-40.

Mean cesium-137 levels (0.17 pCi/g dry weight) were about twice the level observed at the control location (0.09 pCi/g dry weight). Trace amounts of cobalt-58, cobalt-60, and cesium-134 were also detected in bottom sediment samples collected near the condenser discharge. Presence of these activation and fission products in bottom sediments is probably plant related.

V. Figures and Tables

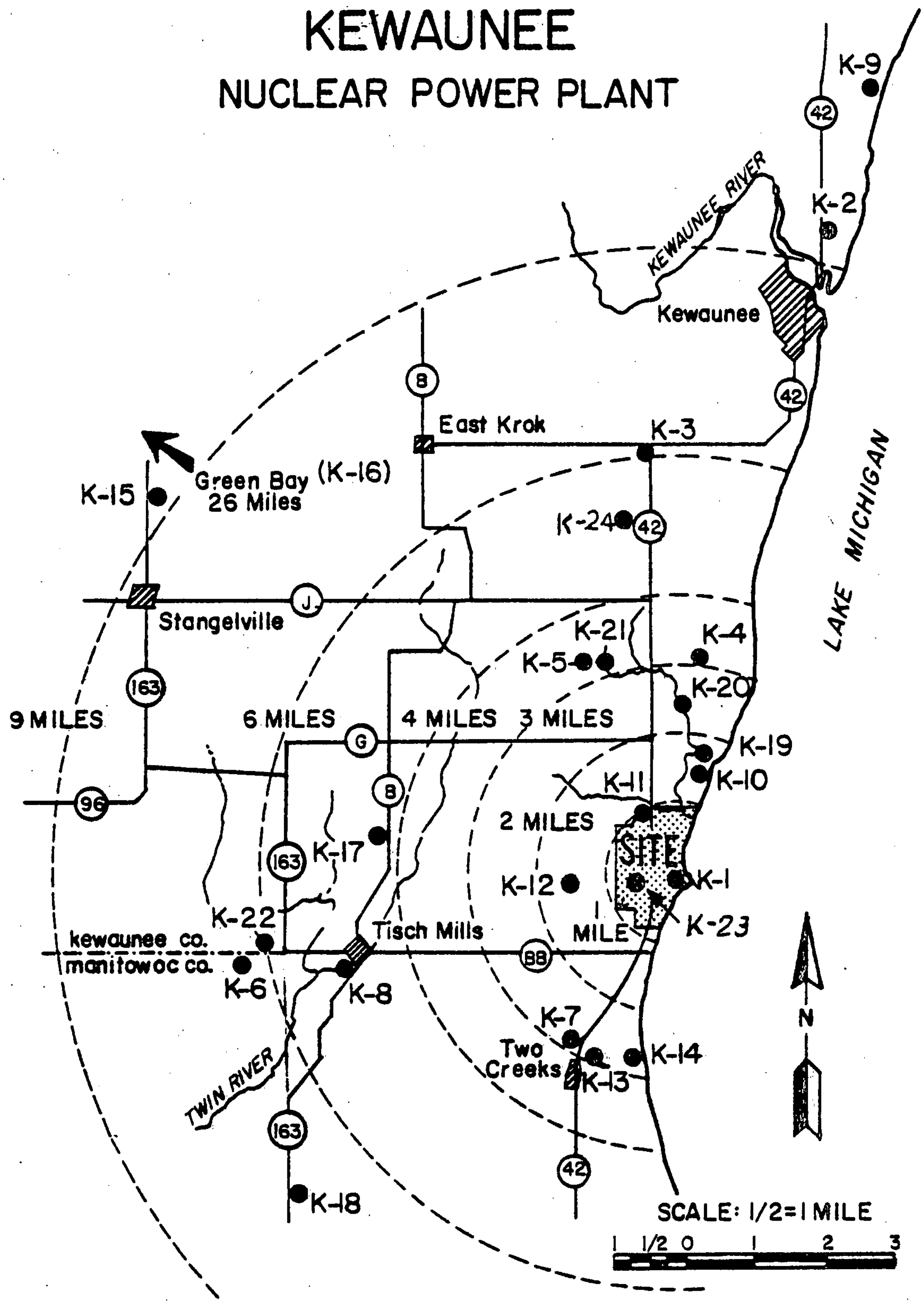

Figure 1. Sampling locations, Kewaunee Nuclear Power Plant.

Table 1. Sampling locations, Kewaunee Nuclear Power Plant.

Code	Type[a]	Distance (miles)[b] and Sector	Location
K-1			Onsite
1a	I	0.62 N	North Creek
1b	I	0.12 N	Middle Creek
1c	I	0.10 N	500' north of condenser discharge
1d	I	0.10 E	Condenser discharge, 500' offshore
1e	I	0.12 S	South Creek
1f	I	0.12 N	Meteorological tower
1g	I	0.06 W	South Well
1h	I	0.12 NW	North Well
1j	I	0.10 S	500' south of condenser discharge
K-2	C	9.5 NNE	WPS Operations building in Kewaunee
K-3	C	6.0 N	Lyle and John Siegmund farm, Route 1, Kewaunee
K-4	I	3.0 N	Dan Stangel farm, Route 1, Kewaunee
K-5	I	3.5 NNW	Ed Paplham farm, Route 1, Kewaunee
K-6	C	6.5 WSW	Leanard Berres farm, Route 1, Denmark
K-7	I	2.75 SSW	Earl Bruemmer farm, Route 3, Two Rivers
K-8	C	5.0 WSW	Saint Mary's Church, Tisch Mills
K-9	C	11.5 NNE	Rostok Water Intake for Green Bay, Wisconsin two miles north of Kewaunee
K-10	I	1.5 NNE	Turner farm, Kewaunee site
K-11	I	1.0 NW	Harlan Ihlenfeldt farm
K-12	I	1.5 WSW	Lecaptain farm, one mile west of site
K-13	C	3.0 SSW	Two Creeks general store
K-14	I	2.5 S	Two Creeks Park, 2.5 miles south of site
K-15	C	9.25 NW	Gas Substation, 1.5 miles north of Stangelville
K-16	C	26 NW	WPS Division Office Building, Green Bay, Wisconsin
K-17	I	4.25 W	Jansky farm, Route 1, Kewaunee
K-18	C	7.0 SSW	Schmidt's Food Stand, Route 163 (3.5 miles south of "BB")
K-19	I	1.75 NNE	Wayne Paral farm, Route 1, Kewaunee
K-20[c]	I	2.5 N	George Struck farm, Route 1, Kewaunee (2.5 miles north of site)
K-21	I	3.25 NNW	Bill Hardtke farm, Route 1, Kewaunee (0.5 miles east of K-5)
K-22	C	6.25 WSW	Alvin Zahorik farm, Route 1, Denmark (0.5 miles east of K-6)
K-23	I	0.5 W	0.5 miles west of plant, Kewaunee Site
K-24[d]	I	5.45 NNW	Fectum farm, Route 1, Kewaunee (2.2 miles north of K-21)

[a] I = indicator; C = control

[b] Distances are measured from reactor stack.

[c] Carl Struck farm replaced by George Struck farm (brother and neighbor) in September 1978.

[d] K-21 replaced by K-24 in September 1978.

Table 2. Type and frequency of collection.

Location	Frequency: Weekly	Bi-Weekly	Monthly	Quarterly	Semi-annually	Annually
K-1						
K-1a			SW		SL	
K-1b			SW	GR[a]		
K-1c				BS[b]		
K-1d			SW	BS[b] BO[a] FI[a]	SL	
K-1e			SW		SL	
K-1f	AP	AI	RC	GR[a] TLD	SO	TLD
K-1g			WW			
K-1h			WW			
K-1j				BS[b]		
K-2	AP	Ai	RC	TLD		TLD
K-3			RC,MI[c]	GR[a] TLD CF[d]	SO	TLD
K-4			RC,MI[c]	GR[a] TLD CF[d]	SO	TLD
K-5			RC,MI[c]	GR[a] TLD CF[d]	SO	TLD
K-6			RC,MI[c]	GR[a] TLD CF[d]	SO	TLD
K-7	AP	AI	RC	TLD		TLD
K-8	AP		RC	TLD		TLD
K-9			SW	BS[b] BO[a]	SL	
K-10				WW		
K-11			PR[e]	WW		
K-12			MI[c]	GR[a] CF[d] WW	SO	
K-13				WW		
K-14			SW	BS[b] BO[a]	SL	
K-15	AP	AI	RC	TLD		TLD
K-16	AP	AI	RC	TLD		TLD
K-17				EG		DM,VE
K-18						VE
K-19			MI[c]	GR[a] CF[d]	SO	
K-20						DM
K-21[f]						DM
K-22						DM
K-23						GRN
K-24						DM

[a] Three times a year, 2nd (April, May, June), 3rd (July, Aug., Sept.), and 4th (Oct., Nov., Dec.) quarters.

[b] To be collected in May, July, Sept., Nov.

[c] Monthly from November through April; weekly from May through October.

[d] First (January, February, March) quarter only.

[e] Based on information supplied by WPS in December 1978, precipitation has been collected at K-11 rather than K-1f since early 1976. The exact date the change was made is unknown.

[f] Replaced by K-24 in September 1978.

Table 3. Sample codes used in Table 2.

Code	Description
AP	Airborne Particulate
AI	Airborne Iodine
RC	Radiation Chamber
TLD	Thermoluminescent Dosimeter
WW	Well Water
PR	Precipitation
MI	Milk
GR	Grass
CF	Cattle Feed
VE	Vegetables
EG	Eggs
SO	Soil
SW	Surface Water
BS	Bottom Sediments
BO	Bottom Organisms
SL	Slime
FI	Fish
DM	Domestic Meat
GRN	Grain

Table 4. Sampling summary, January - December 1978.

Sample Type	Collection Type and Frequency[a]	Number of Locations	Number of Samples Collected	Number of Samples Missed	Remarks
Air Environment					
Airborne particulates	C/W	6	308	10	See text p. 10
Airborne iodine	C/BW	6	160	2	
Ion chambers	C/M	10	179	61	See text p. 10
TLD's	C/Q	10	40	0	
	C/A	10	9	1	See text p. 11
Precipitation	C/M	1	12	0	
Terrestrial Environment					
Milk (May-Oct.)	G/W	6	156	0	
(Nov-Apr.)	G/M	6	36	0	
Well water	G/M	2	24[b]	0	
	G/Q	4	16	0	
Domestic meat	G/A	4	4[c]	0	
Eggs	G/Q	1	4	0	
Vegetables-5 varieties	G/A	2	5	0	
Grain-oats	G/A	1	1	0	
-buckwheat	G/A	1	0	1	See text p. 11
Grass	G/TA	8	24	0	
Cattle feed	G/A	6	6	0	
Soil	G/SA	7	14	0	
Aquatic Environment					
Surface water	G/M	6	72[d]	0	
Fish-2 varieties	G/TA	1	6	0	
Bottom organisms	G/TA	3	9	0	
Slime	G/SA	6	12	0	
Bottom sediments	G/FA	5	20	0	

[a] Type of collection is coded as follows: C/ = continuous; G/ = grab. Frequency is coded as follows: /W = weekly; /M = monthly; /Q = quarterly; /SA = semi-annually; /TA = three times per year; /FA = four times per year; /A = annually; /BW = bi-weekly.

[b] One collection was made at a substitute location.

[c] Two samples were collected at substitute locations.

[d] Three collections were made at a substitute location.

Table 5. Environmental Radiological Monitoring Program Summary.

Name of facility Kewaunee Nuclear Power Plant Docket No. 50-305

Location of facility Kewaunee County, Wisconsin (County, state) Reporting period January-December 1978

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[e]
				Location[d]	Mean (F) Range		
Airborne Particulates (pCi/m^3)	GA 300	0.0005[f]	0.0009 (53/100) (0.0005-0.0028)	K-16 WPS Division Office Bldg., Green Bay 26 mi NW	0.0014 (49/51) (0.0005-0.0071)	0.0011 (128/200) (0.0005-0.0071)	0
	GB 300	0.001	0.025 (90/100) (0.003-0.131)	K-16 WPS Division Office Building, Green Bay 26 mi NW	0.034 (51/51) (0.003-0.149)	0.028 (195/200) (0.001-0.179)	0
	GS 24						
	Be-7	0.020	0.052 (6/8) (0.035-0.060)	K-8 St. Mary's Church, Tisch Mills 5.0 mi WSW	0.066 (3/4) (0.034-0.069)	0.052 (11/16) (0.034-0.073)	0
	Nb-95	0.007	<LLD	-	-	<LLD	0
	Zr-95	0.004	<LLD	-	-	<LLD	0
	Ru-103	0.003	<LLD	-	-	<LLD	0
	Ru-106	0.009	<LLD	-	-	<LLD	0
	Cs-137	0.004	<LLD	-	-	<LLD	0
	Ce-141	0.005	<LLD	-	-	<LLD	0
	Ce-144	0.005	0.019 (1/8) -	K-7 Bruemmer Farm Two Rivers 2.75 mi SSW	0.019 (1/4) -	0.015 (6/16) (0.012-0.017)	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Airborne Iodine (pCi/m^3)	I-131 160	0.01[g]	<LLD	-	-	<LLD	0
Ion Chamber (mR/30 days)	Gamma 179	1	6.4 (71/71) (4.9-8.4)	K-8 St. Mary's Church, Tisch Mills 5.0 mi WSW	7.7 (18/18) (7.2-8.4)	6.8 (108/108) (3.9-9.4)	0
TLD - Quarterly (mR/91 days)	Gamma 40	5	13.1 (16/16) (11.0-15.9)	K-16 WPS Division Office Bldg., Green Bay 26 mi NW	18.1 (4/4) (17.2-19.3)	15.4 (24/24) (11.4-19.8)	0
TLD - Quarterly (mrem/365 days)	Gamma 10	5	52.2 (4/4) (46.6-60.9)	K-16 WPS Division Office Bldg., Green Bay 26 mi NW	72.3 (1/1) -	61.6 (6/6) (49.7-72.3)	0
TLD - Annual (mrem/365 days)	Gamma 9	10	55.0 (3/3) (46.4-66.0)	K-8 St. Mary's Church, Tisch Mills 5.0 mi WSW	72.6 (1/1) -	55.1 (6/6) (4	0
Precipitation (pCi/l)	H-3 12	50	295 (12/12) (165-448)	-	-	None	0
Milk (pCi/l)	I-131 192	0.5	<LLD	K-6 Berres Farm, Denmark 6.5 mi WSW	0.7 (1/32) -	0.7 (1/64) -	0
	Sr-89 72	1.2	4.0 (8/48) (2.0-7.2)	K-12 Lecaptain Farm 1.5 mi WSW	6.4 (2/12) (5.5-7.2)	3.8 (4/24) (2.5-6.0)	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]		LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Milk (cont'd)	Sr-90	72	0.3	2.9 (48/48) (0.6-5.1)	K-12 Lecaptain Farm 1.5 mi WSW	3.4 (12/12) (1.8-5.1)	2.8 (24/24) (1.3-4.0)	0
	GS	72						
	K-40		50	1420 (48/48) (1310-1550)	K-6 Berres Farm Denmark 6.5 mi WSW	1480 (12/12) (1240-1550)	1450 (24/24) (1240-1550)	0
	CS-137		3.7	6.0 (37/48) (3.7-9.7)	K-5 Paplham Farm Kewaunee 3.5 mi NNW	7.1 (10/12) (4.5-9.7)	6.5 (22/24) (3.9-10.0)	0
	Ba-140		3.7	<LLD	-	-	<LLD	0
(g/l)	K stable	72	0.04	1.61 (48/48) (1.48-1.76)	K-6 Berres Farm Denmark 6.5 mi WSW	1.68 (12/12) (1.41-1.76)	1.65 (24/24) (1.41-1.76)	0
(g/l)	Ca	72	0.01	1.27 (48/48) (0.90-2.18)	K-5 Paplham Farm Kewaunee 3.5 mi NNW	1.30 (12/12) (0.90-2.06)	1.26 (24/24) (1.00-2.00)	0
Well Water (pCi/l)	GA	40	4.0	5.0 (3/36) (4.1-5.7)	K-1h North Well onsite 0.12 mi NW	5.7 (1/12) -	2.0 (4/4) (1.4-2.8)	0
	GB	40	2.2	3.4 (24/36) (2.2-4.9)	K-1h North Well onsite 0.12 mi NW	3.9 (10/12) (2.5-4.9)	<LLD	0
	H-3	4	40	<LLD	-	-	None	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Well Water (pCi/l) (cont'd)	K-40 (flame) 40	0.10	1.7 (36/36) (1.0-2.9)	K-1h North Well, onsite 0.12 mi NW	2.0 (12/12) (1.4-2.9)	1.2 (4/4) (1.1-1.4)	0
	Sr-89 4	0.6	<LLD	-	-	None	0
	Sr-90 4	0.6	<LLD	-	-	None	0
Domestic Meat (Chickens) (pCi/g wet)	GA 4	0.02	0.08 (2/3) (0.04-0.11)	K-20 Struck Farm, Kewaunee 2.75 mi N	0.11 (1/1) -	0.09 (1/1) -	0
	GB 4	0.02	1.85 (3/3) (1.50-2.49)	K-20 Struck Farm, Kewaunee 2.75 mi N	2.49 (1/1) -	2.8 (1/1) -	0
	GS 4						
	K-40	0.03	1.65 (3/3) (1.01-2.54)	K-20 Struck Farm, Kewaunee 2.75 mi N	2.54 (1/1) -	1.82 (1/1) -	0
	Cs-137	0.01	<LLD	-	-	<LLD	0
Eggs (pCi/g wet)	GA 4	0.06	<LLD	-	-	None	0
	GB 4	0,01	1.03 (4/4) (0.82-1.14)	K-17 Jansky Farm, Kewaunee 4.25 mi W	1.03 (4/4) (0.82-1.14)	None	0
	Sr-89 4	0.005	<LLD	-	-	None	0
	Sr-90 4	0.003	<LLD	-	-	None	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Eggs (pCi/g wet) (cont'd)	GS 4						
	K-40	0.01	0.87 (4/4) (0.50-1.09)	K-17 Jansky Farm, Kewaunee 4.25 mi W	0.87 (4/4) (0.50-1.09)	None	0
	Cs-137	0.008	<LLD	-	-	None	0
Vegetables (pCi/g wet)	GA 6	0.070	<LLD	K-18 Schmidtt's Food Stand 7.0 mi SSW	0.080 (1/5) -	0.080 (1/5) -	0
	GB 6	0.04	4.83 (1/1) -	K-17 Jansky Farm, Kewaunee 4.25 mi W	4.83 (1/1) -	2.29 (5/5) (0.93-4.00)	0
	Sr-89 6	0.002	<LLD	-	-	<LLD	0
	Sr-90 6	0.001	0.024 (1/1) -	K-17 Jansky Farm, Kewaunee 4.25 mi W	0.024 (1/1) -	0.008 (5/5) (0.0012-0.012)	
	GS 6						
	Be-7	0.056	<LLD	-	-	<LLD	0
	K-40	0.04	2.25 (1/1) -	K-17 Jansky Farm, Kewaunee 4.25 mi W	2.25 (1/1) -	2.23 (5/5) (0.88-4.03)	0
	Nb-95	0.006	<LLD	-	-	<LLD	0
	Zr-95	0.012	<LLD	-	-	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]		LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Vegetables (pCi/g wet) (cont'd)	Ru-103		0.008	<LLD	-	-	<LLD	0
	Ru-106		0.044	<LLD	-	-	<LLD	0
	Cs-137		0.008	<LLD	-	-	<LLD	0
	Ce-141		0.012	<LLD	-	-	<LLD	0
	Ce-144		0.052	<LLD	K-18 Schmidtt's Food Stand 7.0 mi SSW	0.230 (1/5) -	0.230 (1/5) -	0
Grain - Oats (pCi/g wet)	GA	1	0.070	<LLD	-	-	None	0
	GB	1	0.1	4.82 (1/1) -	K-23 Kewaunee Site 0.5 mi W	4.82 (1/1) -	None	0
	Sr-89	1	0.008	<LLD	-	-	None	0
	Sr-90	1	0.01	0.024 (1/1) -	K-23 Kewaunee Site 0.5 mi W	0.024 (1/1) -	None	0
	GS	1						
	Be-7		0.067	<LLD	-	-	None	0
	K-40		0.1	3.96 (1/1) -	K-23 Kewaunee Site 0.5 mi W	3.96 (1/1) -	None	0
	Nb-95		0.008	<LLD	-	-	None	0
	Zr-95		0.011	<LLD	-	-	None	0
	Ru-103		0.008	<LLD	-	-	None	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Grain - Oats (pCi/g wet) (cont'd)	Ru-106	0.057	<LLD	-	-	None	0
	Cs-137	0.009	<LLD	-	-	None	0
	Ce-141	0.011	<LLD	-	-	None	0
	Ce-144	0.044	<LLD	-	-	None	0
Grass (pCi/g wet)	GA 24	0.17	0.23 (6/18) (0.10-0.42)	K-1f Meteorological Tower, onsite 0.12 mi S	0.42 (1/3) -	0.20 (1/6) -	0
	GB 24	0.1	8.1 (18/18) (4.4-16.1)	K-12 Lecaptain Farm 1.5 mi WSW	10.6 (3/3) (6.9-16.1)	9.0 (6/6) (7.3-13.1)	0
	Sr-89 24	0.02	0.03 (1/18) -	K-1b 0.12 mi N and K-3 6.0 mi N	0.03 (2/6) -	0.03 (1/6) -	0
	Sr-90 24	0.01	0.07 (18/18) (0.04-0.19)	K-1b Middle Creek, onsite 0.12 mi N	0.16 (3/3) (0.14-0.19)	0.11 (6/6) (0.04-0.33)	0
	GS 24						
	Be-7	0.17	2.38 (12/18) (0.29-8.26)	K-1f Meteorological Tower, onsite 0.12 mi S	4.18 (3/3) (1.79-8.26)	2.92 (2/6) (2.87-2.97)	0
	K-40	0.1	6.02 (18/18) (3.49-9.34)	K-12 Lecaptain Farm 1.5 mi WSW	7.37 (3/3) (5.76-9.34)	7.17 (6/6) (5.14-10.40)	0
	Nb-95	0.034	0.136 (3/18) (0.050-0.256)	K-1b Middle Creek, onsite 0.12 mi N	0.238 (1/3) -	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

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[e]
				Location[d]	Mean (F) Range		
Grass (pCi/g wet) (cont'd)	Zr-95	0.090	<LLD	-	-	<LLD	0
	Ru-103	0.062	<LLD	-	-	<LLD	0
	Ru-106	0.32	<LLD	-	-	<LLD	0
	Cs-137	0.057	0.124 (4/18) (0.066-0.256)	K-1b Middle Creek, onsite 0.12 mi N	0.130 (3/3) (0.066-0.256)	<LLD	0
	Ce-141	0.091	<LLD	-	-	<LLD	0
	Ce-144	0.37	0.94 (4/18) (0.62-1.73)	K-1b Middle Creek, onsite 0.12 mi N	1.01 (3/3) (0.62-1.73)	0.54 (1/6) -	0
Cattlefeed (pCi/g wet)	GA 6	0.3	<LLD	K-6 Berres Farm Denmark 6.5 mi WSW	0.3 (1/1) -	0.3 (1/2) -	0
	GB 6		7.6 (4/4) (4.1-16.8)	K-4 Stangel Farm Kewaunee 3.0 mi N	16.8 (1/1) -	5.3 (2/2) (4.2-6.4)	0
	Sr-89 6	0.03	0.13 (3/4) (0.09-0.18)	K-12 Lecaptain Farm 1.5 mi WSW	0.18 (1/1) -	0.14 (2/2) (0.11-0.17)	0
	Sr-90 6		0.08 (4/4) (0.03-0.19)	K-4 Stangel Farm Kewaunee 3.0 mi N	0.19 (1/1) -	0.04 (2/2) -	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Cattlefeed (pCi/g wet) (cont'd)	GS 6						
	Be-7	0.3	0.4 (1/1) -	K-5 Paplham Farm Kewaunee 3.5 mi NNW	0.4 (1/1) -	LLD	0
	K-40	1.0	6.1 (4/4) (2.8-13.7)	K-4 Stangel Farm Kewaunee 3.0 mi N	13.7 (1/1) -	3.0 (2/2) (2.6-3.3)	0
	Nb-95	0.03	0.43 (4/4) (0.14-0.84)	K-12 Lecaptain Farm 1.5 me WSW	0.84 (1/1) -	0.69 (2/2) (0.57-0.8	0
	Zr-95	0.06	0.37 (2/4) (0.22-0.52)	K-12 Lecaptain Farm 1.5 mi WSW	0.52 (1/1) -	0.35 (2/2) (0.29-0.4)	0
	Ru-103	0.03	0.09 (2/4) (0.06-0.13)	K-12 Lecaptain Farm 1.5 mi WSW	0.13 (1/1) -	0.08 (1/2) -	0
	Ru-106	0.2	<LLD	-	-	<LLD	0
	Cs-134	0.02	0.03 (1/4) -	K-5 Paplham Farm Kewaunee 3.5 mi NNW	0.03 (1/1) -	<LLD	0
	Cs-137	0.02	0.05 (3/4) (0.03-0.07)	K-12 Lecaptain Farm 1.5 mi WSW	0.07 (1/1) -	0.05 (2/2) (0.05-0.05)	0
	Ce-141	0.06	0.21 (2/4) (0.13-0.28)	K-12 Lecaptain Farm 1.5 mi WSW	0.28 (1/1) -	0.18 (2/2) (0.16-0.2)	0
	Ce-144	0.1	0.6 (3/4) (0.4-0.8)	K-12 Lecaptain Farm 1.5 mi WSW	0.8 (1/1) -	0.4 (2/2) (0.4-0.4)	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Soil (pCi/g dry)	GA 14	3.4	8.8 (9/10) (4.1-13.2)	K-12 Lecaptain Farm 1.5 mi WSW	13.2 (1/2) -	6.4 (4.4) (4.9-7.2)	0
	GB 14	1.4	24.9 (10/10) (13.5-29.7)	K-5 Paplham Farm, Kewaunee 3.5 mi NNW	28.9 (2/2) (28.1-29.7)	24.9 (4/4) (22.0-28.2)	0
	Sr-89 14	0.02	<LLD	K-3 Siegmund Farm, Kewaunee 6.0 mi N	0.025 (1/2) -	0.025 (1/4) -	0
	Sr-90 14	0.01	0.129 (10/10) (0.020-0.230)	K-6 Berres Farm, Denmark 6.5 mi WSW	0.280 (2/2) (0.260-0.300)	0.171 (4/4) (0.054-0.300)	0
	GS 14						
	Be-7	0.35	0.88 (2/10) (0.69-1.06)	K-5 Paplham Farm, Kewaunee 3.5 mi NNW	1.06 (1/2) -	<LLD	0
	K-40	1.4	26.6 (10/10) (18.6-30.1)	K-4 Stangel Farm, Kewaunee 3.0 mi N	30.1 (2/2) (30.0-30.1)	25.7 (4/4) (22.2-28.4)	0
	Nb-95	0.069	0.180 (4/10) (0.137-0.249)	K-5 Paplham Farm, Kewaunee 3.5 mi NNW	0.249 (1/2) -	0.195 (2/4) (0.169-0.221)	0
	Zr-95	0.120	<LLD	K-3 Siegmund Farm, Kewaunee 6.0 mi N	0.215 (1/2) -	0.198 (2/4) (0.180-0.215)	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Soil (pCi/g dry) (cont'd)	Ru-103	0.051	<LLD	K-3 Siegmund Farm, Kewaunee 6.0 mi N	0.148 (1/4) -	0.148 (1/4) -	0
	Ru-106	0.28	0.99 (1/10) -	K-1f Meteorological Tower, onsite 0.12 mi S	0.99 (1/10) -	<LLD	0
	Cs-137	0.05	0.449 (10/10) (0.046-0.834)	K-6 Berres Farm, Denmark 6.5 mi WSW	1.188 (2/2) (1.007-1.369)	0.716 (4/4) (0.146-1.369)	0
	Ce-141	0.087	<LLD	-	-	<LLD	0
	Ce-144	0.31	0.80 (2/10) (0.77-0.83)	K-3 Siegmund Farm, Kewaunee 6.0 mi N	1.03 (1/2) -	1.03 (1/4) -	0
Surface Water (pCi/l)	GA(SS) 71	0.4	0.6 (21/59) (0.4-1.0)	K-9 Rostok Water Intake 11.5 mi NNE	0.7 (1/12) -	0.7 (1/12) -	0
	GS(DS) 71	3.7	5.5 (2/59) (3.9-7.1)	K-1e South Creek, onsite 0.12 mi S	7.1 (1/12) -	<LLD	0
	GA(TR) 71	3.9	5.9 (2/59) (3.9-7.8)	K-1e South Creek, onsite 0.12 mi S	7.8 (1/12) -	<LLD	0
	GB(SS) 71	0.6	1.4 (32/59) (0.6-4.3)	K-14 Two Creeks Park 2.5 mi S	1.8 (10/12) (0.6-4.3)	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

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[e]
				Location[d]	Mean (F) Range		
Surface Water (pCi/l) (cont'd)	GB(DS) 71	0.4	5.4 (59/59) (1.6-15.6)	K-1a North Creek, onsite 0.62 mi N	8.8 (11/11) (3.0-15.6)	2.7 (12/12) (2.4-3.0)	0
	GB(TR) 71	3.4	7.2 (46/59) (3.4-16.2)	K-1a North Creek, onsite 0.62 mi N	10.9 (9/11) (3.0-16.2)	<LLD	0
	H-3 36	170	650 (23/24) (170-6630)	K-14 Two Creeks Park 2.5 mi S	920 (11/12) (220-6630)	210 (11/12) (170-310)	1
	Sr-89 12	1.0	<LLD	-	-	<LLD	0
	Sr-90 12	1.0	<LLD	-	-	<LLD	0
	K-40(flame) 71		3.0 (59/59) (0.8-13.2)	K-1a North Creek, onsite 0.62 mi N	6.0 (11/11) (1.6-13.2)	1.0 (12/12) (0.8-1.2)	2
Fish - Muscle (pCi/g wet)	GA 6	0.04	<LLD	-	-	None	0
	GB 6	0.03	2.76 (6/6) (1.88-3.62)	K-1d Condenser discharge, onsite 0.10 mi E	2.76 (6/6) (1.88-3.62)	None	0
	GS 6						
	K-40	0.03	2.40 (6/6) (1.74-4.00)	K-1d Condenser discharge, onsite 0.10 mi E	2.40 (6/6) (1.74-4.00)	None	0
	Cs-137	0.066	0.164 (4/6) (0.080-0.229)	K-1d Condenser discharge, onsite 0.10 mi E.	0.164 (4/6) (0.080-0.229)	None	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Fish - Bones (pCi/g wet)	GA 6	0.9	<LLD	-	-	None	0
	GB 6	0.7	3.3 (6/6) (2.5-4.7)	K-1d Condenser discharge, onsite 0.10 mi E	3.3 (6/6) (2.5-4.7)	None	0
	Sr-89 6	0.6	<LLD	-	-	None	0
	Sr-90 6	0.1	0.31 (6/6) (0.18-0.58)	K-1d Condenser discharge, onsite 0.10 mi E	0.31 (6/6) (0.18-0.58)	None	0
Bottom Organisms (pCi/g dry)	GA 9	94	<LLD	-	-	<LLD	0
	GB 9	250	<LLD	-	-	<LLD	0
Periphyton (slime) (pCi/g wet)	GA 12	0.032	1.64 (9/10) (0.14-2.90)	K-1a North Creek, onsite 0.62 mi N	2.71 (2/2) (2.60-2.82)	0.59 (2/2) (0.19-0.98)	0
	GB 12	0.1	5.58 (10/10) (3.45-8.81)	K-1a North Creek, onsite 0.62 mi N	6.87 (2/2) (5.57-8.16)	4.40 (2/2) (4.07-4.72)	0
	Sr-89 12	0.29	<LLD	-	-	<LLD	0
	Sr-90 12	0.270	0.422 (1/10) -	K-1b Middle Creek, onsite 0.62 mi N	0.422 (1/2) -	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[a] Range[c]	Location with Highest Annual Mean		Control Locations Mean (F) Range	Number of non-routine Results[e]
				Location[d]	Mean (F) Range		
Periphyton (slime) (pCi/g wet) (cont'd)	GS 12						
	Be-7	1.2	1.37 (1/10) -	K-1d Condenser discharge, onsite 0.10 mi E	1.37 (1/10) -	<LLD	0
	K-40	2.0	2.7 (5/10) (2.0-4.3)	K-1a North Creek, onsite 0.62 mi N	3.5 (2/2) (2.6-4.3)	<LLD	0
	Mn-54	0.10	<LLD	-	-	<LLD	0
	Co-58	0.15	0.499 (3/10) (0.092-0.950)	K-1d Condenser discharge, onsite 0.10 mi E	0.521 (2/2) (0.092-0.950)	<LLD	0
	Co-60	0.13	<LLD	-	-	<LLD	0
	Nb-95	0.097	0.106 (2/10) (0.098-0.114)	K-1d Condenser discharge, onsite 0.10 mi E	0.106 (2/2) (0.098-0.114)	<LLD	0
	Zr-95	0.17	0.170 (1/10) -	K-1d Condenser discharge, onsite 0.10 mi E	0.170 (1/2) -	<LLD	0
	Ru-103	0.14	<LLD	-	-	<LLD	0
	Ru-106	0.71	<LLD	-	-	<LLD	0
	Cs-134	0.12	<LLD	-	-	<LLD	0
	Cs-137	0.12	0.189 (5/10) (0.142-0.280)	K-1a North Creek, nsite 0.62 mi N	0.280 (1/2) -	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

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[e]
				Location[d]	Mean (F) Range		
Periphyton (slime) (pCi/g wet)	Ce-141	0.16	<LLD	-	-	<LLD	0
	Ce-144	0.56	0.95 (5/10 (0.61-1.54)	K-1d Condenser discharge, onsite 0.10 mi E	1.28 (2/2) (0.01-1.54)	0.89 (2/2) (0.79-0.99)	0
Bottom Sediments (pCi/g dry)	GA 20	5.0	6.0 (2/16) (5.0-6.9)	K-1d Condenser discharge, onsite 0.10 mi E	6.9 (1/4) -	<LLD	0
	GB 20	1.4	8.4 (16/16) (3.1-13.6)	K-1d Condenser discharge, onsite 0.10 mi E	10.3 (4/4) (7.7-13.6)	7.7 (4/4) (6.0-9.1)	0
	Sr-89 20	0.02	<LLD	-	-	<LLD	0
	Sr-90 20	0.02	<LLD	-	-	<LLD	0
	GS 20						
	K-40	1.4	11.1 (16/16) (6.9-16.1)	K-1d Condenser discharge, onsite 0.10 mi E	13.1 (4/4) (10.5-16.1)	8.9 (4/4) (7.0-10.4)	0
	Co-58	0.03	0.25 (7/16) (0.07-0.67)	K-12 Onsite 500' S at discharge	0.27 (3/4) (0.07-0.64)	<LLD	0
	Co-60	0.03	0.25 (4/16) (0.09-0.66)	K-1d Condenser discharge, onsite 0.10 mi E	0.39 (2/4) (0.12-0.66)	<LLD	0
	Cs-134	0.03	0.07 (5/16) (0.03-0.10)	K-1d Condenser discharge, onsite 0.10 mi E	0.09 (2/4) (0.08-0.10	<LLD	0

Table 5. (continued)
Name of facility Kewaunee Nuclear Power Plant

Sample Type (Units)	Type and Number of Analyses[a]	LLD[b]	Indicator Locations Mean (F)[c] Range[c]	Location with Highest Annual Mean: Location[d]	Location with Highest Annual Mean: Mean (F) Range	Control Locations Mean (F) Range	Number of non-routine Results[e]
Bottom Sediments (pCi/g dry) (cont'd)	Cs-137	0.03	0.17 (16/16) (0.08-0.26)	K-1d Condenser discharge, onsite 0.10 mi E	0.22 (4/4) (0.17-0.26)	0.09 (4/4) (0.07-0.10)	0

[a] GA = gross alpha, GB = gross beta, GS = gamma spectroscopy, 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] Nonroutine results are those which exceed ten times the control station value. If no control station value is available, the result is considered nonroutine if it exceeds ten times the pre-operational value for the location.
[f] Eight higher LLD values resulting from low air volume have been excluded from determination of LLD.
[g] One higher LLD value resulting from low air volume has been excluded from determination of LLD.

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Appendix A

Crosscheck Program Results

Appendix A

Crosscheck Program Results

The Nuclear Sciences Section of Hazleton Environmental Sciences Corporation has participated in interlaboratory comparison (cross-check) programs since the formulation of its quality control program in December 1971. These programs are operated by agencies which supply environmental-type samples (e.g., milk or water) containing concentrations of radionuclides known to the issuing agency but not to participant laboratories. Participant laboratories measure the concentrations of specified radionuclides and report them to the issuing agency. Several months later, the agency reports the known values to the participant laboratories and specifies control limits. The purpose of participation in the program is to provide an independent check on the laboratory's analytical procedures and to alert it to any possible problems. Results consistently higher or lower than the known values or outside the control limits indicate a need to check the instruments or procedures used.

The results in Table A-1 were obtained for milk and water samples during the period 1975-8 through participation in the environmental sample crosscheck program conducted by the U. S. Environmental Protection Agency as specified in Footnote a. The results in Table A-2 were obtained for thermoluminescent dosimeters (TLD's) during the period 1976-7 through participation in programs under the sponsorships listed in Footnotes b and c.

Table A-1. Crosscheck program results, milk and water samples, 1975-8.[a]

Lab Code	Sample Type	Date Coll.	Analysis	pCi/l or mg/l[b] Lab Result ±2σ[c]	EPA Known Value	EPA Control Limits (3σ, n=1
STM-40	Milk	Jan. 1975	Sr-89	<2	0	±15
			Sr-90	73±2.5	75	±11.4
			I-131	99±4.2	101	±15.3
			Cs-137	76±0.0	75	±15
			Ba-140	<3.7	0	±15.0
			K(mg/l)	1470±5.6	1510	±228
STW-45	Water	April 1975	Cr-51	<14	0	–
			Co-60	421±6	425	±63.9
			Zn-65	487±6	497	±74.7
			Ru-106	505±16	497	±74.7
			Cs-134	385±3	400	±60.0
			Cs-137	468±3	450	±67.5
STW-47	Water	April 1975	H-3	1459±144	1499	±1002
STW-48	Water	June 1975	H-3	2404±34	2204	±1044
STW-49	Water	June 1975	Cr-51	<14	0	–
			Co-60	344±1	350	±53
			Zn-65	330±5	327	±49
			Ru-106	315±7	325	±49
			Cs-134	291±1	304	±46
			Cs-137	387±2	378	±57
STW-53	Water	Aug. 1975	H-3	3117±64	3200	±1083
STW-54	Water	Aug. 1975	Cr-51	233±11	255	±38
			Co-60	305±1	307	±46
			Zn-65	289±3	281	±42
			Ru-106	346±5	379	±57
			Cs-134	238±1	256	±38
			Cs-137	292±2	307	±46

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	pCi/l or mg/l[b] Lab Result ±2σ[c]	EPA Known Value	EPA Control Limits (3σ, n=1)
STW-58	Water	Oct. 1975	H-3	1283±80	1203	±988
STM-61	Milk	Nov. 1975	Sr-90	68.9±2.1	74.6	±11.2
			I-131	64.6±3.8	75	±15
			Cs-137	75.6±20	75	±15
			Ba-140	<3.7	0	-
			K-(mg/l)	1435±57	1549	±233
STW-63	Water	Dec. 1975	H-3	1034±39	1002	±972
STW-64	Water	Dec. 1975	Cr-51	<14	0	-
			Co-60	211±1	203	±30.5
			Zn-65	215±6	201	±30.2
			Ru-106	171±9	181	±27.2
			Cs-134	198±2	202	±30.3
			Cs-137	152±4	151	±22.7
STW-68	Water	Feb. 1976	H-3	1124±31	1080	±978
STW-78	Water	June 1976	H-3	2500±44	2502	±1056
STW-84	Water	Aug. 1976	H-3	3097±21	3100	±1080
STM-86	Milk	Sept. 1976	Sr-89	29±2.0	45	±15
			Sr-90	30±1.0	30	±4.5
			I-131	100±8.6	120	±18
			Ba-140	50±10.1	85	±15
			Cs-137	17±1.5	20	±15
			K(mg/l)	-	1540	±231
STM-91	Milk	Nov. 1976	I-131	83±0.6	85	±15
			Ba-140	<4	0	-
			Cs-137	12±1.7	11	±15
			K(mg/l)	1443±31	1510	±228

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	pCi/l or mg/l[b] Lab Result ±2σ[c]	EPA Known Value	EPA Control Limits (3σ, n=1)
STW-93	Water	Dec. 1976	Cr-51	105±15	104	±15
			Co-60	<4	0	-
			Zn-65	97±4	102	±15
			Ru-106	87±3	99	±15
			Cs-134	85±4	93	±15
			Cs-137	103±4	101	±15
STW-94	Water	Dec. 1976	H-3	2537±15	2300	±1049
STM-97	Milk	March 1977	I-131	55±2.5	51	±15
			Ba-140	<6	0	-
			Cs-137	34±1	29	±15
			K(mg/l)	1520±35	1550	±233
STW-101	Water	April 1977	H-3	1690±62	1760	±1023
STM-103	Milk	May 1977	Sr-89	38±2.6	44	±15
			Sr-90	12±2.1	10	±4.5
			I-131	59±2.1	50	±15
			Ba-140	53±4.4	72	±15
			Cs-137	14±1.2	10	±15
			K(mg/l)	1533±21	1560	±234
STW-105	Water	June 1977	Cr-51	<14	0	-
			Co-60	29±2	29	±15
			Zn-65	74±7	74	±15
			Ru-106	64±8	62	±15
			Cs-134	41±1	44	±15
			Cs-137	35±3	33	±15
STW-107	Water	June 1977	Ra-226	4.7±0.3	5.1	±2.4

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	pCi/l or mg/l[b] Lab Result ±2σ[c]	EPA Known Value	EPA Control Limits (3σ, n=1)
STW-113	Water	Aug. 1977	Sr-89	13±0[d]	14	±15
			Sr-90	10±2[d]	10	±4.5
STW-116	Water	Sept. 1977	Gross α	12±6	10	±15
			Gross β	32±6	30	±15
STW-118	Water	Oct. 1977	H-3	1475±29	1650	±1017
STW-119	Water	Oct. 1977	Cr-51	132±14	153	±24
			Co-60	39±2	38	±15
			Zn-65	51±5	53	±15
			Ru-106	63±6	74	±15
			Cs-134	30±3	30	±15
			Cs-137	26±1	25	±15
STW-136	Water	Feb. 1978	H-3	1690±270	1680	±1020
STW-150	Water	April 1978	H-3	2150±220	2220	±1047
STW-151	Water	April 1978	Gross α	20±1	20	±15
			Gross β	56±4	59	±15
			Sr-89	19±2	21	±15
			Sr-90	8±1	10	±4.5
			Ra-226	NA[e]	-	-
			Ra-228	NA[e]	-	-
			H-3	112±12	0	-
			Co-60	19±3	20	±15
			Cs-134	16±1	15	±15
			Cs-137	<2	0	-

Table A-1. (continued)

Lab Code	Sample Type	Date Coll.	Analysis	Lab Result $\pm 2\sigma$[c] (pCi/l or mg/l[b])	EPA Known Value (pCi/l or mg/l[b])	EPA Control Limits (3σ, n=1) (pCi/l or mg/l[b])
Stm-152	Milk	April 1978	Sr-89	85±4	101	±15
			Sr-90	8±1	9	±4.5
			I-131	78±1	82	±15
			Cs-137	29±3	23	±15
			Ba-140	<11	0	-
			K	1503±90	1500	±225
STW-154[f]	Water	May 1978	Gross α	12±1	13	±15
			Gross β	21±4	18	±15

a Results obtained by the Nuclear Sciences Section of Hazleton Environmental Sciences Corporation as a participant in the environmental sample crosscheck program operated by the Intercomparison and Calibration Section, Quality Assurance Branch, Environmental Monitoring and Support Laboratory, U. S. Environmental Protection Agency, (EPA), Las Vegas, Nevada.

b All results are in pCi/l except for elemental potassium (K) data which are in mg/l.

c Unless otherwise indicated, Lab result given is mean ± 2 standard deviations for three determinations.

d Mean ± 2 standard deviations of two determinations.

e NA. Not analyzed.

f Analyzed but not reported to EPA.

Table A-2. Crosscheck program results, thermoluminescent dosimeters (TLD's).

Lab Code	TLD Type	Measurement	mR: Lab Result $\pm 2\sigma$[a]	mR: Known Value	mR: Average (all participants)
115-2[b]	CaF_2:Mn Bulb	Gamma-Field	17.0±1.9	17.1[c]	16.4±7.7[d]
		Gamma-Lab	20.8±4.1	21.3[c]	18.8±7.6[d]
115-3[e]	CaF_2:Mn Bulb	Gamma-Field	30.7±3.2	34.9±4.8[f]	31.5±3.0[d]
		Gamma-Lab	89.6±6.4	91.7±14.6[f]	86.2±24.0[d]

a Lab result given is the mean ± 2 standard deviations of three determinations.

b Second International Intercomparison of Environmental Dosimeters conducted in April of 1976 by the Health and Safety Laboratory (HASL), New York, New York, and the School of Public Health of the University of Texas, Houston, Texas.

c Value determined by sponsor of the intercomparison.

d Mean ± 2 standard deviations of results obtained by all laboratories participating in program.

e Third International Intercomparison of Environmental Dosimeters conducted in summer of 1977 by Oak Ridge National Laboratory and the School of Public Health of the University of Texas, Houston, Texas.

f Value ± 2 standard deviations as determined by sponsor of the intercomparison.

Appendix B

Statistical Notations

Statistical Notations

1. Single Measurement

Each single measurement is reported as $x \pm s$

where x = value of the measurement

$s = 2\sigma$ counting uncertainty (corresponding to the 95% confidence level).

In cases where the activity is found to be below the lower limit of detection it is reported as

$<L$

where L = lower limit of detection based on a 3σ counting uncertainty for a background sample.

2. Computation of Means and Standard Deviations

A. The mean, $\bar{x}$, and standard deviation, s, of a set of n numbers, x, . x_1, ...x_n are defined as follows:

$$\bar{x} = \frac{1}{n} \Sigma x$$

$$s = \sqrt{\frac{\Sigma (x-\bar{x})^2}{n-1}}$$

B. Monthly and quarterly means are calculated using all detectable results.

C. Annual means and standard deviations are calculated using only those results which are above the highest lower limit of detection (LLD).

D. If all but one of the values are less than the highest LLD, the single value, x, and the associated two sigma error are reported.

E. If the standard deviation is zero, the mean value, $\bar{x}$, and the largest two sigma error are reported.

F. If all values are less than the highest LLD, no value is reported.

G. All numbers are rounded upwards if the last digit is five or greater.

Appendix C

Maximum Permissible Concentrations of Radioactivity in Air and Water

Table C-1. Maximum permissible concentrations of radioactivity in air and water above natural background in unrestricted areas.[a]

Air			Water		
Gross alpha	3	pCi/m^3	Strontium-89	3,000	pCi/l
Gross beta	100	pCi/m^3	Strontium-90	300	pCi/l
Iodine-131[b]	0.14	pCi/m^3	Cesium-137	20,000	pCi/l
			Barium-140	20,000	pCi/l
			Iodine-131	300	pCi/l
			Potassium-40[c]	3,000	pCi/l
			Gross alpha	30	pCi/l
			Gross beta	100	pCi/l
			Tritium	$3x10^6$	pCi/l

[a] Taken from Code of Federal Regulations Title 10, Part 20, Table II and appropriate footnotes. Concentrations may be averaged over a period not greater than one year.

[b] From 10 CFR 20 but adjusted by a factor of 700 to reduce the dose resulting from the air-grass-cow-milk-child pathway.

[c] A natural radionuclide.

9.0 Circulating Water Data for Kewaunee Nuclear Power Plant, 1977.

Following are the corrected tables for circulating water data at the Kewaunee Nuclear Power Plant for the year 1977.

ENVIRONMENTAL TECHNICAL SPECIFICATIONS

(APPENDIX B) Revised 1977 Data

This section employs the subsection numbering consistent with the specific subject covered in Appendix B.

2.1 Thermal

2.1.1 Maximum ΔT Across the Condenser

During normal operation of the plant, the ΔT (^{o}F) across the condenser was recorded hourly. The monthly averages and maximums are as follows:

	ΔT (Ave)	ΔT High Day (Ave)	ΔT Maximum Recorded	ΔT Max. Daily (Ave)
Jan	18.5	22.8	24.3	22.7
Feb	Refueling 1/17/77 through 3/24/77			
Mar	8.1	8.8	11.7	10.0
Apr	12.6	14.4	16.1	13.6
May	13.5	15.5	17.5	14.7
Jun	14.2	17.0	19.8	15.6
Jul	13.4	14.3	15.0	13.9
Aug	13.8	15.8	17.0	14.6
Sep	14.5	15.7	23.0	15.2
Oct	14.2	15.3	15.8	14.7
Nov	13.5	14.2	14.6	13.9
Dec	15.5	22.4	24.4	17.7

2.12 Maximum Discharge Temperatures

The maximum discharge temperature and the average of the maximum temperatures was:

	Discharge Temp. (Max) ^{o}F	Discharge Temp. (Ave Max) ^{o}F
Jan	65.5	59.5
Feb	Refueling Shutdown	
Mar	57.7	55.7
Apr	66.8	60.2
May	72.0	66.8
Jun	74.2	71.4
Jul	75.7	69.0
Aug	83.1	71.5
Sep	84.3	74.9
Oct	76.7	68.8
Nov	69.5	61.8
Dec	66.1	57.1