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CLINTON POWER STATION

Annual Radiological Groundwater Protection Program Report

1 January Through 31 December 2007

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I. Summary and Conclusions

In 2006, Exelon instituted a comprehensive program to evaluate the impact of station operations on groundwater and surface water in the vicinity of Clinton Power Station. This evaluation involved numerous station personnel and contractor support personnel. This report covers groundwater and surface water samples, collected outside of the Licensee required Off-Site Dose Calculation Manual (ODCM) requirements, both on and off station property in 2007. During that time period, 92 analyses were performed on 69 samples from 23 locations. The monitoring was conducted in two phases.

In assessing all the data gathered for this report, it was concluded that the operation of Clinton Power Station had no adverse radiological impact on the environment, and there are no known active releases into the groundwater or surface water at Clinton Power Station.

Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective Lower Limits of Detection (LLDs) as specified in NUREG-1302 in any of the groundwater or surface water samples. In the case of tritium, Exelon specified that the independent laboratory achieve a lower limit of detection 10 times lower than that required by the United States Environmental Protection Agency (USEPA) regulation.

Strontium-89/90 was not evaluated in 2007.

Tritium was not detected in any of the groundwater or surface water samples at concentrations greater than the United States Environmental Protection Agency (USEPA) drinking water standard (and the Nuclear Regulatory Commission Reporting Limit) of 20,000 pCi/L. Background levels of tritium were detected at concentrations greater than the self-imposed LLD of 200 pCi/L in 3 of 69 groundwater monitoring locations. The tritium concentrations ranged from 634 ± 131 pCi/L to 704 ± 157 pCi/L.

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II. Introduction

The Clinton Power Station (CPS), consisting of one approximately 1140 MW gross electrical power output boiling water reactor is located in Harp Township, DeWitt County, Illinois. CPS is owned and operated by AmerGen Energy Company and became operational in 1987. Unit No. 1 went critical on 15 February 1987. The site encloses approximately 13,730 acres. This includes the 4,895 acre, man-made cooling lake and about 452 acres of property not owned by AmerGen. The plant is situated on approximately 150 acres. The cooling water discharge flume – which discharges to the eastern arm of the lake – occupies an additional 130 acres. Although the nuclear reactor, supporting equipment and associated electrical generation and distribution equipment lie in Harp Township, portions of the aforementioned 13,730 acre plot reside within Wilson, Rutledge, DeWitt, Creek, Nixon and Santa Anna Townships.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) and Environmental Inc. (Midwest Labs) on samples collected in 2006.

A. Objective of the RGPP

The long-term objectives of the RGPP are as follows:

1. Identify suitable locations to monitor and evaluate potential impacts from station operations before significant radiological impact to the environment and potential drinking water sources.
2. Understand the local hydrogeologic regime in the vicinity of the station and maintain up-to-date knowledge of flow patterns on the surface and shallow subsurface.
3. Perform routine water sampling and radiological analysis of water from selected locations.
4. Report new leaks, spills, or other detections with potential radiological significance to stakeholders in a timely manner.
5. Regularly assess analytical results to identify adverse trends.
6. Take necessary corrective actions to protect groundwater resources.

B. Implementation of the Objectives

The objectives identified have been implemented at Clinton Power Station as discussed below:

1. Exelon and its consultant identified locations as described in the Phase 1 study. Phase 1 studies were conducted by Connestoga Rovers and Associates (CRA) and the results and conclusions were made available to state and federal regulators as well as the public on an Exelon web site in station specific reports. http://www.exeloncorp.com/ourcompanies/powergen/nuclear/Tritium.htm

2. The Clinton Power Station reports describe the local hydrogeologic regime. Periodically, the flow patterns on the surface and shallow subsurface are updated based on ongoing measurements.

3. Clinton Power Station will continue to perform routine sampling and radiological analysis of water from selected locations.

4. Clinton Power Station has implemented new procedures to identify and report new leaks, spills, or other detections with potential radiological significance in a timely manner.

5. Clinton Power Station staff and consulting hydrogeologist assess analytical results on an ongoing basis to identify adverse trends.

C. Program Description

1. Sample Collection

Sample locations can be found in Table A–1 and Figures A–1 and A–2, Appendix A.

Groundwater and Surface Water

Samples of water are collected, managed, transported and analyzed in accordance with approved procedures following regulatory methods. Both groundwater and surface water are collected. Sample locations, sample collection frequencies and analytical frequencies are controlled in accordance with approved station procedures. Contractor and/or station personnel are trained in the collection, preservation management, and shipment of samples, as well as in documentation of sampling events. Analytical laboratories are subject to internal quality assurance programs, inter-laboratory cross-check programs, as well as nuclear industry audits. Station personnel review and evaluate all analytical data deliverables after initial review by the contractor.

Analytical data results are reviewed by both station personnel and

an independent hydrogeologist for adverse trends or changes to hydrogeologic conditions.

D. Characteristics of Tritium (H-3)

Tritium (chemical symbol H-3) is a radioactive isotope of hydrogen. The most common form of tritium is tritium oxide, which is also called "tritiated water." The chemical properties of tritium are essentially those of ordinary hydrogen.

Tritiated water behaves the same as ordinary water in both the environment and the body. Tritium can be taken into the body by drinking water, breathing air, eating food, or absorption through skin. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted primarily through urine with a clearance rate characterized by an effective biological half-life of about 14 days. Within one month or so after ingestion, essentially all tritium is cleared. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a by-product in reactors producing electricity, and in special production reactors, where the isotopes lithium-7 and/or boron-10 are activated to produce tritium. Like normal water, tritiated water is colorless and odorless. Tritiated water behaves chemically and physically like non-tritiated water in the subsurface, and therefore tritiated water will travel at the same velocity as the average groundwater velocity.

Tritium has a half-life of approximately 12.3 years. It decays spontaneously to helium-3 (3He). This radioactive decay releases a beta particle (low-energy electron). The radioactive decay of tritium is the source of the health risk from exposure to tritium. Tritium is one of the least dangerous radionuclides because it emits very weak beta radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues is generally uniform and is dependent on the water content of the specific tissue.

III. Program Description

A. Sample Analysis

This section describes the general analytical methodologies used by TBE and EIML to analyze the environmental samples for radioactivity for the

Clinton Power Station RGPP in 2007.

In order to achieve the stated objectives, the current program includes the following analyses:

1. Concentrations of gamma emitters in groundwater and surface water.

2. Concentrations of strontium in groundwater and surface water.

3. Concentrations of tritium in groundwater and surface water.

B. Data Interpretation

The radiological data collected prior to Clinton Power Station becoming operational were used as a baseline with which these operational data were compared. For the purpose of this report, Clinton Power Station was considered operational at initial criticality. Several factors were important in the interpretation of the data:

1. Lower Limit of Detection and Minimum Detectable Concentration

The lower limit of detection (LLD) is specified by federal regulation as a minimum sensitivity value that must be achieved routinely by the analytical parameter.

2. Laboratory Measurements Uncertainty

The estimated uncertainty in measurement of tritium in environmental samples is frequently on the order of 50% of the measurement value.

Statistically, the exact value of a measurement is expressed as a range with a stated level of confidence. The convention is to report results with a 95% level of confidence. The uncertainty comes from calibration standards, sample volume or weight measurements, sampling uncertainty and other factors. Exelon reports the uncertainty of a measurement created by statistical process (counting error) as well as all sources of error (Total Propagated Uncertainty or TPU). Each result has two values calculated. Exelon reports the TPU by following the result with plus or minus ± the estimated sample standard deviation, as TPU, that is obtained by propagating all sources of analytical uncertainty in measurements.

Analytical uncertainties are reported at the 95% confidence level in this report for reporting consistency with the AREOR.

Gamma spectroscopy results for each type of sample were grouped as follows:

For groundwater and surface water 13 nuclides, Be-7, K-40, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Nb-95, Zr-95, Cs-134, Cs-137, Ba-140 and La-140 were reported.

C. Background Analysis

A pre-operational radiological environmental monitoring program (pre-operational REMP) was conducted to establish background radioactivity levels prior to operation of the Station. The environmental media sampled and analyzed during the pre-operational REMP were atmospheric radiation, fall-out, domestic water, surface water, marine life, milk, and vegetation. The results of the monitoring were detailed in the report entitled, Environmental Radiological Monitoring for Clinton Power Nuclear Power Station, Illinois Power Company, Annual Report 1987, May 1988.

The pre-operational REMP contained analytical results from samples collected from the surface water and groundwater.

1. Background Concentrations of Tritium

The purpose of the following discussion is to summarize background measurements of tritium in various media performed by others.

a. Tritium Production

Tritium is created in the environment from naturally occurring processes both cosmic and subterranean, as well as from anthropogenic (i.e., man-made) sources. In the upper atmosphere, "Cosmogenic" tritium is produced from the bombardment of stable nuclides and combines with oxygen to form tritiated water, which will then enter the hydrologic cycle. Below ground, "lithogenic" tritium is produced by the bombardment of natural lithium present in crystalline rocks by neutrons produced by the radioactive decay of naturally abundant uranium and thorium. Lithogenic production of tritium is usually negligible compared to other sources due to the limited abundance of lithium in rock. The lithogenic tritium is introduced directly to groundwater.

A major anthropogenic source of tritium and strontium-90 comes from the former atmospheric testing of thermonuclear weapons. Levels of tritium in precipitation increased significantly during the 1950s and early 1960s, and later with additional testing, resulting in the release of significant amounts of tritium to the atmosphere. The Canadian heavy water nuclear power reactors, other commercial power reactors, nuclear research and weapons production continue to influence tritium concentrations in the environment.

b. Precipitation Data

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. Two publicly available databases that provide tritium concentrations in precipitation are Global Network of Isotopes in Precipitation (GNIP) and USEPA's RadNet database. GNIP provides tritium precipitation concentration data for samples collected world wide from 1960 to 2006. RadNet provides tritium precipitation concentration data for samples collected at stations through out the U.S. from 1960 up to and including 2006. Based on GNIP data for sample stations located in the U.S. Midwest, tritium concentrations peaked around 1963. This peak, which approached 10,000 pCi/L for some stations, coincided with the atmospheric testing of thermonuclear weapons. Tritium concentrations in surface water showed a sharp decline up until 1975, followed by a gradual decline since that time. Tritium concentrations in Midwest precipitation have typically been below 100 pCi/L since around 1980. Tritium concentrations in wells may still be above the 200 pCi/L detection limit from the external causes described above.

c. Surface Water Data

Tritium concentrations are routinely measured in Clinton Lake. Illinois surface water data were typically less than 100 pCi/L.

According to the USEPA, surface water data typically has an uncertainty ± 70 to 100 pCi/L 95% confidence bound on each given measurement. Therefore, the typical background data provided may be subject to measurement uncertainty of approximately ± 70 to 100 pCi/L.

The radio-analytical laboratory is counting tritium results to an Exelon specified LLD of 200 pCi/L. Typically, the lowest positive measurement will be reported within a range of 40 – 240 pCi/L or 140 ± 100 pCi/L. Clearly, these sample results cannot be distinguished as different from background at this concentration.

IV. Results and Discussion

A. Groundwater Results

Groundwater

Baseline samples were collected from on and off-site wells during two (2) Phases at the station. Analytical results and anomalies are discussed below.

Tritium

Samples from 23 locations were analyzed for tritium activity (Table B–I.1 Appendix B). Tritium values ranged from below the Exelon imposed LLD of 200 pico-curies per liter to 704 pCi/l.

Strontium

Strontium-90 was not evaluated in 2007.

Gamma Emitters

Naturally occurring Beryllium-7 was not detected in 2007. Additionally, naturally occurring Potassium-40 was detected in three of 22 samples. The concentrations ranged from 58 pCi/liter to 118 pCi/liter. No other gamma emitting nuclides were detected. (Table B–I.2, Appendix B).

APPENDIX A

LOCATION DESIGNATION OF THE ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)

TABLE A-1: Radiological Groundwater Protection Program - Sampling Locations, Clinton Power Station, 2007

Site	Site Type
B-3	Monitoring Well
MW-1	Monitoring Well
MW-CL-12I	Monitoring Well
MW-CL-13I	Monitoring Well
MW-CL-13S	Monitoring Well
MW-CL-14S	Monitoring Well
MW-CL-15I	Monitoring Well
MW-CL-15S	Monitoring Well
MW-CL-16S	Monitoring Well
MW-CL-17S	Monitoring Well
MW-CL-18I	Monitoring Well
MW-CL-18S	Monitoring Well
MW-CL-19S	Monitoring Well
MW-CL-2	Monitoring Well
MW-CL-20S	Monitoring Well
MW-CL-21S	Monitoring Well
MW-CL-22S	Monitoring Well
SW-CL-1	Surface Water
SW-CL-2	Surface Water
SW-CL-4	Surface Water
SW-CL-5	Surface Water
SW-CL-6	Surface Water
SW-CL-7	Surface Water

APPENDIX B

DATA TABLES OF THE ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)

TABLE B-I.1 CONCENTRATIONS OF TRITIUM IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF CLINTON POWER STATION, 2007

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3
B-3	04/24/07	< 168
B-3	07/24/07	< 166
B-3	11/02/07	< 185
MW-1	04/24/07	< 165
MW-1	07/24/07	< 171
MW-1	11/02/07	< 186
MW-CL-12I	04/25/07	< 173
MW-CL-12I	07/23/07	< 171
MW-CL-12I	11/01/07	< 187
MW-CL-13I	04/25/07	< 166
MW-CL-13I	07/24/07	< 173
MW-CL-13I	11/02/07	< 187
MW-CL-13S	04/25/07	< 167
MW-CL-13S	07/24/07	< 171
MW-CL-13S	11/02/07	< 191
MW-CL-14S	04/25/07	176 ± 113
MW-CL-14S	07/23/07	< 174
MW-CL-14S	11/01/07	< 189
MW-CL-15I	04/24/07	< 172
MW-CL-15I	07/24/07	< 172
MW-CL-15I	11/02/07	< 183
MW-CL-15S	04/24/07	< 168
MW-CL-15S	07/24/07	< 170
MW-CL-15S	11/02/07	< 190
MW-CL-16S	04/25/07	< 170
MW-CL-16S	07/23/07	< 170
MW-CL-16S	11/01/07	< 190
MW-CL-17S	04/25/07	< 168
MW-CL-17S	07/23/07	< 173
MW-CL-17S	11/01/07	< 189
MW-CL-18I	04/25/07	< 164
MW-CL-18I	07/23/07	< 171
MW-CL-18I	11/01/07	< 184
MW-CL-18S	04/25/07	< 169
MW-CL-18S	07/23/07	< 170
MW-CL-18S	11/01/07	< 197
MW-CL-19S	04/25/07	< 170
MW-CL-19S	07/23/07	< 171
MW-CL-19S	11/01/07	< 191
MW-CL-2	04/24/07	< 171
MW-CL-2	07/24/07	< 168
MW-CL-2	11/02/07	< 186

TABLE B-I.1 CONCENTRATIONS OF TRITIUM IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF CLINTON POWER STATION, 2007

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3
MW-CL-20S	04/24/07	< 167
MW-CL-20S	07/24/07	< 173
MW-CL-20S	11/02/07	< 194
MW-CL-21S	04/25/07	634 ± 131
MW-CL-21S	07/24/07	662 ± 134
MW-CL-21S	11/02/07	704 ± 157
MW-CL-22S	04/25/07	< 166
MW-CL-22S	07/23/07	< 162
MW-CL-22S	11/01/07	< 191

TABLE B-I.2 **CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES COLLECTED IN THE VICINITY OF CLINTON POWER STATION, 2007**

RESULTS IN UNITS OF PCI/LITER ± SIGMA

STC	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
B-3	11/02/07	< 26	< 22	< 3	< 3	< 7	< 3	< 5	< 3	< 6	< 2	< 3	< 30	< 10
MW-1	11/02/07	< 34	< 62	< 3	< 4	< 8	< 4	< 6	< 4	< 7	< 3	< 4	< 39	< 14
MW-CL-2	1111/2/7	(1)												
MW-CL-12I	11/01/07	< 31	< 62	< 3	< 4	< 8	< 3	< 6	< 4	< 7	< 3	< 3	< 35	< 14
MW-CL-13I	11/02/07	< 38	< 35	< 3	< 4	< 9	< 3	< 7	< 4	< 7	< 3	< 4	< 38	< 13
MW-CL-13S	11/02/07	< 20	114 ± 22	< 2	< 2	< 5	< 2	< 4	< 2	< 4	< 2	< 2	< 26	< 8
MW-CL-14S	11/01/07	< 21	< 41	< 2	< 2	< 6	< 2	< 4	< 3	< 4	< 2	< 2	< 26	< 9
MW-CL-15I	11/02/07	< 20	< 43	< 2	< 3	< 6	< 2	< 5	< 3	< 4	< 2	< 2	< 26	< 9
MW-CL-15S	11/02/07	< 20	< 37	< 2	< 2	< 5	< 2	< 4	< 3	< 4	< 2	< 2	< 26	< 8
MW-CL-16S	11/01/07	< 21	< 17	< 2	< 2	< 5	< 2	< 4	< 3	< 4	< 2	< 2	< 26	< 8
MW-CL-17S	11/01/07	< 26	< 43	< 2	< 3	< 7	< 2	< 5	< 3	< 5	< 2	< 2	< 31	< 11
MW-CL-18I	11/01/07	< 24	< 37	< 2	< 3	< 7	< 2	< 4	< 3	< 5	< 2	< 2	< 32	< 12
MW-CL-18S	11/01/07	< 31	< 51	< 3	< 3	< 8	< 3	< 6	< 4	< 7	< 3	< 3	< 46	< 14
MW-CL-19S	11/01/07	< 28	< 47	< 3	< 3	< 7	< 3	< 5	< 3	< 5	< 2	< 3	< 40	< 14
MW-CL-20S	11/02/07	< 35	< 59	< 3	< 4	< 9	< 3	< 6	< 4	< 7	< 3	< 3	< 48	< 15
MW-CL-21S	11/02/07	< 26	< 46	< 2	< 3	< 7	< 2	< 5	< 3	< 5	< 2	< 2	< 35	< 12
MW-CL-22S	11/01/07	< 22	< 34	< 2	< 3	< 6	< 2	< 4	< 3	< 4	< 2	< 2	< 33	< 12

(1) WELL RAN DRY. ONLY ENOUGH WATER COLLECTED FOR H-3 ANALYSIS

TABLE B-II.1 CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF CLINTON POWER STATION, 2007

RESULTS IN UNITS OF PCI/LITER ± 2 SIGMA

SITE	COLLECTION DATE	H-3
CPS LAKE	06/07/07	< 153
SW-CL-1	04/25/07	< 159
SW-CL-1	07/23/07	< 160
SW-CL-1	10/31/07	< 193
SW-CL-2	04/24/07	< 166
SW-CL-2	07/23/07	< 161
SW-CL-2	10/31/07	< 192
SW-CL-4	04/24/07	< 160
SW-CL-4	07/23/07	< 161
SW-CL-4	10/31/07	< 194
SW-CL-5	04/24/07	< 166
SW-CL-5	07/23/07	< 162
SW-CL-5	10/31/07	< 191
SW-CL-6	04/24/07	< 165
SW-CL-6	07/23/07	< 166
SW-CL-6	10/31/07	< 193
SW-CL-7	04/24/07	< 164
SW-CL-7	07/23/07	< 162
SW-CL-7	10/31/07	< 196

TABLE B-II.2 **CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES COLLECTED IN THE VICINITY OF CLINTON POWER STATION, 2007**

RESULTS IN UNITS OF PCI/LITER ± SIGMA

STC	COLLECTION PERIOD	Be-7	K-40	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
SW-CL-1	10/31/07	< 23	< 36	< 2	< 2	< 6	< 2	< 4	< 2	< 5	< 2	< 2	< 33	< 11
SW-CL-2	10/31/07	< 30	118 ± 33	< 3	< 3	< 8	< 3	< 5	< 3	< 6	< 2	< 3	< 49	< 15
SW-CL-4	10/31/07	< 30	< 46	< 2	< 3	< 7	< 3	< 5	< 3	< 5	< 2	< 2	< 47	< 14
SW-CL-5	10/31/07	< 30	58 ± 37	< 3	< 3	< 7	< 2	< 5	< 3	< 5	< 2	< 2	< 45	< 14
SW-CL-6	10/31/07	< 29	< 23	< 3	< 3	< 7	< 3	< 6	< 3	< 5	< 2	< 3	< 45	< 15
SW-CL-7	10/31/07	< 29	< 24	< 3	< 3	< 7	< 2	< 5	< 3	< 6	< 2	< 2	< 41	< 14