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NL-11-068

June 10, 2011

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: 2010 Annual Radioactive Effluent Release Report, Revision 1
Indian Point Unit Nos. 1, 2 and 3
Docket Nos. 50-03, 50-247, 50-286
License Nos. DPR-5. DPR-26, DPR-64

REFERENCE: 1. Letter NL-11-039, '2010 Annual Radioactive Effluent Release Report', dated 4/22/2011.

Dear Sir or Madam:

The purpose of this letter is to correct an error that was discovered in the Radiological Effluent Release Report: 2010, on page 35 of the 40CFR190 Total Dose summary table in Reference 1. For the Groundwater component, percent limit values were erroneously given in place of the mrem dose values. The Groundwater dose section (Section H) is correct; it is only the summary table on page 35 that is being revised by this letter. This error was entered into Entergy Corrective Action Program as CR-IP3-2011-02991.

Enclosure 1 to this letter resubmits the entire Entergy Nuclear Operations, Inc.'s (ENO's) 2010 Radioactive Effluent Release Report. Page 35 of the report has been revised, as shown by revision markers in the right margin.

There are no new commitments contained in this letter. If you have any questions or require additional information, please contact me at 914-734-6710.

Sincerely,

RW/mb

cc: next page

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IE48

Enclosure: 1. Radioactive Effluent Release Report: 2010.

cc: Mr. William Dean, Regional Administrator, NRC Region 1
Mr. John Boska, Senior Project Manager, NRC NRR DORL
IPEC NRC Resident Inspector's Office
Mr. Stephen Giebel, IPEC NRC Unit 1 Project Manager
Mr. Francis J. Murray, President and CEO, NYSERDA (w/o enclosure)
Mr. Paul Eddy, New York State Department of Public Service (w/o enclosure)
Mr. Timothy Rice, Bureau of Hazardous Waste & Radiation Mgmt, NYSDEC
Mr. Robert Snyder, NYS Department of Health
Mr. Chuck Nieder, NYS Department of Environmental Conservation
Mr. Jason Martinez, American Nuclear Insurers
Chief, Compliance Section, New York State DEC, Division of Water Regional Water Engineer, New York State DEC

# ENCLOSURE 1 TO NL-11-068

# Radioactive Effluent Release Report: 2010

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT UNIT 1, 2, and 3 NUCLEAR POWER PLANTS
DOCKET Nos. 50-03, 50-247, and 50-286

# Radioactive Effluent Release Report: 2010

Facility: Indian Point Energy Center (Indian Point Units 1, 2, and 3)

Licensee: Entergy Nuclear Operations, Inc (Entergy)

This information is provided in accordance with the requirements of Regulatory Guide 1.21. The numbered sections of this report reference corresponding sections of the subject Guide, pages 10 to 12. This report includes effluent information from Indian Point units 1, 2, and 3. Units 1 and 2 share effluent processing equipment and Technical Specifications. In this site report, releases from Unit 1 are included with Unit 2, while Unit 3 releases are calculated and shown separately.

## A. Supplemental Information

### 1. Regulatory Limits

Indian Point Energy Center is subject to limits on radioactive waste releases that are set forth in the Offsite Dose Calculation Manual (ODCM), Parts I and II, as defined in the Technical Specifications. ODCM Part I, also known as the Radiological Effluent Controls (or RECS) contains the specific requirements and controls, while ODCM Part II (calculational methodologies) contains the details necessary to perform offsite dose calculations from the sampling and monitoring outlined in the RECS.

### 2. Maximum Permissible Concentration

#### a) Airborne Releases

Maximum concentrations and compliance with 10CFR20 release rate limits are controlled by the application of Radiation Monitor setpoints, preliminary grab sampling, and conservative procedural guidance for batch and continuous releases. These measures, in conjunction with plant design, preclude approaching release rate limits, per the ODCM.

#### b) Liquid Effluents

Proximity to release rate and total release limits is controlled through the application of a calculated Allowed Diluted Concentration (ADC) and ALARA guidance with regard to dilution flow and maximum tank concentration. The ADC is used to determine a Radiation Monitor setpoint associated with an estimated amount of Beta activity, as well as the measured gamma activity. ADC is defined in the station ODCM as a means of assuring compliance with the release rate limits of 10CFR20, as defined by the application of ten times the Effluent Concentrations of the new 10CFR20.

Liquid effluents are further controlled by the application of proceduralized ALARA limits such as a MINIMUM dilution flow of 100,000 gpm required for batch discharges, a maximum gamma concentration of 5E-5 uCi/ml (without gas or tritium) for routine effluents, and procedural guidance for optimizing decay and treatment of liquid waste.

3. Average Energy

The average energies ($\bar{E}$) of the radionuclide mixtures in releases of fission and activation gases were as follows:

Units 1 and 2:

| | | | | |
|---|---|---|---|---|
| 1st Quarter | $\bar{E}_\beta$ = | 1.60E-01 Mev/dis | $\bar{E}_\gamma$ = | 1.20E-01 Mev/dis |
| 2nd Quarter | $\bar{E}_\beta$ = | 2.49E-01 Mev/dis | $\bar{E}_\gamma$ = | 4.49E-01 Mev/dis |
| 3rd Quarter | $\bar{E}_\beta$ = | 2.58E-01 Mev/dis | $\bar{E}_\gamma$ = | 4.70E-01 Mev/dis |
| 4th Quarter | $\bar{E}_\beta$ = | 3.13E-01 Mev/dis | $\bar{E}_\gamma$ = | 7.15E-01 Mev/dis |

Unit 3:

| | | | | |
|---|---|---|---|---|
| 1st Quarter | $\bar{E}_\beta$ = | 4.34E-01 Mev/dis | $\bar{E}_\gamma$ = | 1.17E+00 Mev/dis |
| 2nd Quarter | $\bar{E}_\beta$ = | 4.31E-01 Mev/dis | $\bar{E}_\gamma$ = | 1.16E+00 Mev/dis |
| 3rd Quarter | $\bar{E}_\beta$ = | 3.93E-01 Mev/dis | $\bar{E}_\gamma$ = | 9.40E-01 Mev/dis |
| 4th Quarter | $\bar{E}_\beta$ = | 4.21E-01 Mev/dis | $\bar{E}_\gamma$ = | 1.10E+00 Mev/dis |

4. Measurements and Approximations of Total Radioactivity

a) Fission and Activation Gases

Analyses of effluent gases are performed in compliance with the requirements of the RECS (ODCM Part I). In the case of isolated tanks (batch releases), the total activity discharged is based on an isotopic analysis of each batch with the volume of gas in the batch corrected to standard temperature and pressure.

Vapor containment purge and pressure relief (vent) discharges, which routinely total less than 150 hours/quarter in duration, have been treated as batch releases. However, both types of releases from the Vapor Containment are performed randomly with regard to time of day and duration (release periods were not dependant solely on time of day or atmospheric condition). Therefore, determination of doses due to Vapor Containment releases includes the use of annual average dispersion data, as defined in NUREG 0133, Section 3.3.

At least one complete isotopic concentration analysis of containment air is performed monthly and compared to a process monitor's reading. Pressure reliefs are quantified by scaling subsequent releases with the monitor's reading, applying the mixture from the grab sample. In this fashion, the base grab sample defines the mixture and the activity released. The monitor scales the release up or down and provides continuous indication of potential leaks.

Isotopic analyses for each vapor containment purge are taken prior to and during the purge. This information is combined with the volume of air in each discharge to calculate the quantity of activity released from these discharges.

The continuous building discharges are based on weekly samples of ventilation air analyzed for isotopic content. This information is combined with total air volume discharged and the process radiation monitor readings to determine the quantity of activity from continuous discharges.

b/c) Iodines and Particulates

Iodine-131 and particulate releases are quantified by collecting a continuous sample of ventilation air on a Triethylenediamine (TEDA) impregnated, activated charcoal cartridge and a glass-fiber filter paper. These samples are changed weekly as required in the RECS. The concentration of isotopes found by analysis of these samples is combined with the volume of air discharged during the sampling period to calculate the quantity of activity discharged.

If no I-131 is identified in weekly vent samples, "-" is entered in Table 1A. A typical Minimum Detectable Activity (MDA) for weekly I-131 analyses is 1.0E-13 uCi/cc, which is 100 times lower than ODCM requirements.

If I-131 is identified in any routine weekly sample, it is added to the table and other iodine isotopic concentrations are then determined on a 24-hour sample at least once per month. The concentration of each isotope is analytically determined by ratioing the activities with weekly media for I-131. This activity is combined with the volume of air discharged during the sampling period to calculate the quantity of activity discharged.

A compositing method of analyzing for gross alpha is used per the station ODCMs. An absence of any positive Gross Alpha value for the quarter is identified on Table 1A as "-". A typical MDA for gross alpha is 8.0E-14 uCi/cc, which is over 100 times lower than ODCM requirements.

d) Carbon-14

C-14 release quantification details are discussed in Section E.

e) Liquid Effluents

A sample of each batch discharge is taken and an isotopic analysis is performed in compliance with requirements specified in the ODCM. Proportional composite samples of continuous discharges are taken and analyzed per the ODCM, as well. Isotopic concentration data are combined with the information on volume discharged to determine the amount of each isotope discharged.

A compositing method of analyzing for gross alpha is used per the station ODCM. When there has been no positive Gross Alpha identified in a quarter, "-" is entered in Table 2A. A typical MDA value for Gross Alpha in liquids is 5E-8 uCi/ml, which is two times lower than ODCM requirements.

Liquid Effluent volumes of waste released on Table 2A are differentiated between processed fluids (routine liquid waste and Unit 1's North Curtain Drain), and water discharged through monitored pathways identified in the ODCM, but NOT processed (SG Blowdown and Unit 1's Sphere Foundation Drain Sump).

The unprocessed water may still contain trace levels of contamination (generally only tritium) and as such, is identified as liquid waste. Curie and dose data from unprocessed fluid is included in the following tables, along with all other liquid effluent, continuous or batch, processed or not. Processed and unprocessed water is differentiated only to prevent confusion with regard to measures undertaken to convert liquid to solid waste (resin cleanup). Therefore, volumes of processed and unprocessed liquid waste are reported separately on Table 2A.

5. Batch Releases

Airborne:

| Unit 1 and 2 Airborne Releases | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| Number of Batch Releases | | 60 | 45 | 54 | 45 | 204 |
| Total Time Period | (min) | 4100 | 3200 | 2940 | 2670 | 12900 |
| Maximum Time Period | (min) | 175 | 330 | 144 | 100 | 330 |
| Average Time Period | (min) | 68 | 71 | 55 | 59 | 63 |
| Minimum Time Period | (min) | 5 | 2 | 1 | 5 | 1 |

| Unit 3 Airborne Releases | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| Number of Batch Releases | | 41 | 45 | 47 | 42 | 175 |
| Total Time Period | (min) | 5780 | 6470 | 6200 | 6320 | 24800 |
| Maximum Time Period | (min) | 213 | 250 | 236 | 199 | 250 |
| Average Time Period | (min) | 141 | 144 | 132 | 151 | 142 |
| Minimum Time Period | (min) | 4 | 8 | 7 | 4 | 4 |

Liquid:

| Unit 1 and 2 Liquid Releases | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| Number of Batch Releases | | 36 | 24 | 17 | 5 | 82 |
| Total Time Period | (min) | 8530 | 2980 | 3320 | 469 | 15300 |
| Maximum Time Period | (min) | 780 | 382 | 550 | 107 | 780 |
| Average Time Period | (min) | 237 | 124 | 195 | 94 | 187 |
| Minimum Time Period | (min) | 88 | 90 | 91 | 78 | 78 |

| Unit 3 Liquid Releases | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| Number of Batch Releases | | 12 | 8 | 17 | 14 | 51 |
| Total Time Period | (min) | 1350 | 874 | 1870 | 1540 | 5620 |
| Maximum Time Period | (min) | 140 | 118 | 117 | 114 | 140 |
| Average Time Period | (min) | 112 | 109 | 110 | 110 | 110 |
| Minimum Time Period | (min) | 102 | 104 | 98 | 104 | 98 |

Average Stream Flow :

Hudson River flow information is obtained from the Department of the Interior, United States Geological Survey (USGS). These data are received after review from the USGS, approximately 18 months after initial data collection. This information is included in the effluents report as the data becomes available.

Estimated Average Stream Flows of the Hudson River at Indian Point:

| Year | Quarter | Flow (cfs) |
|---|---|---|
| 2008 | Fourth | 76,400 |
| 2009 | First | 72,100 |
| 2009 | Second | 77,700 |
| 2009 | Third | 49,370 |

6. Abnormal Releases

a) Liquid

General Groundwater

IPEC's groundwater monitoring program and the process (model) for quantification of effluent remained generally unchanged in 2010, from that of 2009 and earlier. The overall approach and formulation of the Precipitation Mass Balance Model remained unchanged. Additional groundwater elevation data, collected since the initiation of the Long Term Monitoring Program in 2007, was applied to enhance the accuracy of the model through further calibrations to the larger data set. Details of these refinements are included in second quarter 2009 Long Term Monitoring Report, GZA, September 22, 2010.

The resulting offsite dose as a result of the station's continuing natural attenuation was very small, similar to 2009's totals. Groundwater doses are included in the total dose table of Section E, the Dose-To-Man section of this report. Details of the IPEC Radiological Groundwater Monitoring Program are provided in Section H of this report, and include the following:

1) an update on the current condition of IPEC's GW natural attenuation,
2) a discussion of the removal of fuel (source term) from Unit 1, and
3) per the ODCM and NEI 07-07, a summary table of all groundwater radio-analyses results in 2010.

Storm Drain Contamination Events, January 2010 and April 2010

In January, 2010, a small increase in routine levels of tritium and trace gamma was discovered in a storm drain outside Unit 2's Primary Building, near the interface with the Fuel Storage Building (MH-9). Investigation identified that the contamination had originated in late November 2009, from leaking hoses during an operation involving RWST cleanup to remove silica prior to Unit 2's outage. Silica removal in the RWST is required to improve clarity in the pool, transfer canal, and reactor cavity. The silica is a product of boraflex grid support plates in the unit 2 pool. During the cleanup event, some hose leakage accumulated in a burm under the skid, and was inadvertently released to the local concrete driveway area, some of which entered MH-9. The investigation led to several corrective actions for future improvements, including operation of the skid indoors, where sumps and hoses can be more closely monitored, and where these leaks do not become "spills". Contamination discovered from this event was evaluated for release impact and found to be arithmetically insignificant with regard to effluent release (< 1E-6 mrem).

In April, Storm Drain A-2 outside Unit 3 Fuel Storage Building (FSB) was identified with increased tritium. After a long investigation, the increase was attributed to a lack of ventilation in the nearby FSB. The building's exhaust fan was moved to Unit 2 to replace a failed fan, leaving no operable exhaust fan for Unit 3. While attempts were made to repair, replace, or build a new fan from parts, a ground-level airborne effluent term was understood to be unavoidable from small openings such as the ventilation inlet plenum on the roof. Airborne effluent was monitored, calculated, and reported, based on measurements of FSB atmosphere (for tritium and other contaminants), pool level, temperature and barometric pressure, etc. These parameters were used to complete a mass balance for the lost tritium.

While the airborne effluent was being monitored and reported, it became evident that in addition to the airborne effluent, the released vapor was condensing (particularly on the FSB roof) and traveling (via a direct pipe roof drain) into a local storm drain a few feet from the south-east corner of the spent fuel building (identified as storm drain A-2). The direct contribution from the FSB roof was verified by collecting a sample directly from the roof drain pipe going into the basin of drain A-2. This drain system continued to indicate elevated H-3 throughout the year, as the FSB ventilation remained out of service.

During this interval, tritium and other monitoring occurred at various levels in the FSB, to ensure an accurate representation of potential effluent out the door. All airborne effluent was quantified at ground level. While the tritium leaving the building was determined to be approximately the same as routine operation, the effluent airborne dose calculations indicated increased mrem over this interval, due to the ground level release of this tritium, versus routine releases up the Plant Vent (where the release point is atop the containment building). Despite exceeding department goals, the effluent airborne dose from this tritium release remained a very small portion of the ODCM limit.

An assessment was also performed to determine a bounding offsite dose calculation for the liquid pathway from the storm drain system. The curies and dose from this pathways were insignificant with regard to total site effluent, but for completeness, added to the monthly reports. No attempt was made to subtract the liquid curies as already quantified, as these totals were insignificant with respect to routine releases.

Operating Experience was distributed to the industry covering lessons learned from this event and its associated challenges to radiological effluents.

b) Gaseous

See the discussion above, regarding the Unit 3 Fuel Storage Building ground level release of tritium, while the exhaust fan remained inoperable.

7. ODCM Reporting Requirements

ODCM Part I requires reporting of prolonged outages of effluent monitoring equipment. Also required in this report is notification of any changes in the land use census, the Radiological Environmental Monitoring Program (REMP), or exceeding the total curie content limitations in outdoor tanks.

During this reporting period, the following ODCM required effluent monitoring equipment was out of service (OOS) for periods greater than 30 consecutive days:

| Instrument | Effected Interval | Details |
|---|---|---|
| Unit 2<br>Plant Vent<br><br>Process<br>Flow Rate<br>Indicator<br><br>SV2-DPT | 01-01-10 00:00<br><br>to<br><br>01-01-11 00:00<br><br>(365 days) | This instrument failed its routine calibration in October of 2009. Further testing was performed to compare this ODCM-required instrument with a redundant instrument that appeared to be working. Investigation ensued as to why the values were outside desirable tolerances with each other. Parts (not readily available) for the ODCM instrument were deemed necessary and ordered from vendor. After parts arrived, calibration was scheduled after a refueling outage. Test procedures were updated to improve the calibration process. Safety conditions related to frozen surfaces delayed completion of the calibration. This instrument was returned to service on March, 28, 2011.<br><br>Compensatory measurements (estimates of process flow) were conducted per the ODCM and lower tier procedures. In addition, a redundant, non-ODCM instrument was evaluated as a backup. This instrument's reading compared favorably with manual measurements of vent flow rate to increase confidence.<br><br>While compensatory action continued, the backup instrument readings provided additional continuous indication. |
| Unit 3<br>Primary<br>Water<br>Storage Tank<br><br>Level<br>Instrument<br><br>LT-1131 | 1-1-10 00:00<br><br>to<br><br>01-21-10 12:41<br><br>(32.6 days total)<br>(21.5 in 2010) | The level instrument failed in mid December, 2009, due to a failure of a freeze protection strip heater. The heater strip was replaced, but the level instrument then failed its calibration retest. A new instrument was pursued with no success and eventually determined not to be feasible. Instead, parts were procured, the instrument repaired and successfully calibrated. It was returned to service on Jan 21, 2010. The total duration of the out of service time was 33 days, splitting 2009 and 2010.<br><br>While out of service, compensatory measures (level estimates) were performed per the ODCM and lower tier procedures whenever water was moved into or out of the tank. |
| Unit 3 Steam Generator Blowdown Monitor<br><br>R-19 | 5-14-10 14:37<br>to<br>6-16-10 10:40<br><br>(32.6 days) | The control room lost communication with monitor in the field. Continuous work to repair was not possible, due to prioritization established with high work load and limited resources. Because it could not be worked continuously, multiple teams were used to troubleshoot. The complexity of the system and lack of continuity of repair teams challenged timely resolution, which had been on track for completion several days earlier. |

7. ODCM Reporting Requirements (continued)

| Instrument | Effected Interval | Details |
|---|---|---|
| Unit 3 Radioactive Machine Shop Vent Process Flow meter | 9-22-10 15:03 to after 1-01-11 00:00 (100.4 days) | This instrument failed it's 2-yr calibration, later determined to be due to faulty testing equipment. The instrument was tested on 1-25-11 and determined to be functional. It was then returned to service.<br><br>The instrument was officially listed as OOS during this interval, so all ODCM required compensatory actions were fulfilled. |
| Unit 3 Plant Vent Noble Gas Monitor<br><br>R-14 | 11-3-10 08:35 to 12-14-10 09:36 (41.0 days) | This backup Plant Vent monitor's detector required repair. Due to the primary instrument (R-27) being in service and unaffected, a high work load, and limited resources, repair and recalibration of R-14 was given secondary prioritization. No compensatory action was required during this interval because the primary instrument remained in service. |
| Unit 1 Stack Vent Noble Gas Monitor<br><br>R-60 | 12-12-10 00:15 to after 1-01-11 00:00 ( > 45 days) (20.0 in 2010) | The monitor's memory failed during calibration. After repair, an independent failure occurred with a non-required sub-channel that rendered the noble gas channel inoperable. Prioritization, high work load, limited resources, flooding in the work area, and an on-going modification to retire the superfluous (troubling) channel combined to delay repairs, which are expected in April, 2011. Compensatory actions were completed during this interval. |
| Unit 3 Steam Generator Blowdown Monitor<br><br>R-19 | 11-8-10 23:25 to after 1-01-11 00:00 (>53.0 days) | A containment isolation valve for one Steam Generator sample line to this monitor was declared inoperable. Therefore, the other valve was shut, securing flow from one SG. Difficulty in accessing and repairing the valve drove a decision to leave this line isolated until the upcoming refueling outage, while simultaneously investigating options for routing flow to the monitor from other lines. Compensatory sampling was performed from an unaffected line to SG Blowdown Recovery. |

Other Reporting Criteria:

***Tank Curie Limits***

During this reporting period, no tank curie limits in outdoor tanks were exceeded.

***ODCM and PCP changes:***

There were no changes to the Process Control Program or ODCM in 2010.

Indian Point Energy Center

(Units 1, 2, and 3)

# RADIOACTIVE EFFLUENT RELEASE REPORT

## B. GASEOUS EFFLUENTS

2010

TABLE 1A

INDIAN POINT 1 and 2 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

| A. Fission & Activation Gases | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 | Est. Total % Error |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 1.51E+00 | 4.04E-02 | 1.24E-01 | 3.96E-02 | 1.71E+00 | ±25 |
| 2. Average release rate | uCi/sec | 1.94E-01 | 5.13E-03 | 1.55E-02 | 4.98E-03 | 5.42E-02 | |
| **B. Iodines** | | | | | | | |
| 1. Total Iodine-131 | Ci | - | - | - | - | 0.00E+00 | ±25 |
| 2. Average release rate | uCi/sec | - | - | - | - | 0.00E+00 | |
| **C. Particulates** | | | | | | | |
| 1. Total Release, with half-life > 8 days | Ci | - | - | - | 3.59E-06 | 3.59E-06 | ±25 |
| 2. Average release rate | uCi/sec | - | - | - | 4.52E-07 | 1.14E-07 | |
| 3. Gross Alpha | Ci | - | - | - | - | 0.00E+00 | ±25 |
| **D. Tritium** | | | | | | | |
| 1. Total release | Ci | 2.83E+00 | 1.76E+00 | 7.21E+00 | 2.52E+00 | 1.43E+01 | ±25 |
| 2. Average release rate | uCi/sec | 3.63E-01 | 2.24E-01 | 9.06E-01 | 3.17E-01 | 4.54E-01 | |
| **E. Carbon-14** | | | | | | | |
| 1. Total release | Ci | 2.30E+00 | 2.30E+00 | 2.30E+00 | 2.30E+00 | 9.18E+00 | |
| 2. Average release rate | uCi/sec | 2.95E-01 | 2.92E-01 | 2.89E-01 | 2.89E-01 | 2.91E-01 | |
| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 | |

- Indicates < MDA

TABLE 1C
INDIAN POINT 1 and 2 **CONTINUOUS** GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

Nuclides Released

**1) Fission Gases**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| | | | | | | |
| Total for Period | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

**2) Iodines**

| | | | | | | |
|---|---|---|---|---|---|---|
| I-131 | Ci | - | | - | - | 0.00E+00 |
| I-133 | Ci | - | - | - | - | 0.00E+00 |
| I-135 | Ci | - | - | - | - | 0.00E+00 |
| Total for Period | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

**3) Particulates**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cs-137 | Ci | - | - | - | 3.59E-06 | 3.59E-06 |
| Total for Period | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.59E-06 | 3.59E-06 |

- Indicates < MDA

TABLE 1C
INDIAN POINT 1 and 2 - **BATCH** GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

Nuclides Released

**1) Fission Gases**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Ar-41 | Ci | 7.81E-02 | 1.28E-02 | 3.84E-02 | 2.14E-02 | 1.51E-01 |
| Kr-85 | Ci | - | - | - | - | 0.00E+00 |
| Kr-85m | Ci | 1.32E-03 | 1.55E-06 | 5.83E-04 | - | 1.90E-03 |
| Kr-87 | Ci | 6.78E-04 | 1.21E-06 | 4.69E-04 | - | 1.15E-03 |
| Kr-88 | Ci | 1.57E-03 | 2.81E-06 | 1.07E-03 | - | 2.64E-03 |
| Xe-131m | Ci | 3.86E-03 | 1.10E-03 | 1.40E-04 | 2.99E-04 | 5.40E-03 |
| Xe-133 | Ci | 1.35E+00 | 2.43E-02 | 7.29E-02 | 1.78E-02 | 1.47E+00 |
| Xe-133m | Ci | 1.61E-02 | 3.06E-06 | - | 4.15E-05 | 1.62E-02 |
| Xe-135 | Ci | 5.03E-02 | 2.06E-03 | 8.58E-03 | 2.19E-05 | 6.10E-02 |
| Xe-135m | Ci | 3.37E-03 | 2.62E-06 | 1.09E-03 | - | 4.47E-03 |
| Xe-138 | Ci | 4.49E-04 | 8.41E-07 | 2.75E-04 | - | 7.24E-04 |
| Total for Period | Ci | 1.51E+00 | 4.04E-02 | 1.24E-01 | 3.96E-02 | 1.71E+00 |

**2) Iodines**

Not Applicable for Batch Releases

**3) Particulates**

Not Applicable for Batch Releases

- Indicates < MDA

TABLE 1A

INDIAN POINT 3 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

A. Fission & Activation Gases

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 | Est. Total % Error |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 4.65E-02 | 5.42E-02 | 6.03E-02 | 4.98E-02 | 2.11E-01 | ± 25 |
| 2. Average release rate | uCi/sec | 5.98E-03 | 6.90E-03 | 7.59E-03 | 6.27E-03 | 6.69E-03 | |

B. Iodines

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Iodine-131 | Ci | - | - | - | - | 0.00E+00 | ± 25 |
| 2. Average release rate | uCi/sec | - | - | - | - | 0.00E+00 | |

C. Particulates

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release, with half-life > 8 days | Ci | - | - | - | - | 0.00E+00 | ± 25 |
| 2. Average release rate | uCi/sec | - | - | - | - | 0.00E+00 | |
| 3. Gross Alpha | Ci | - | - | - | - | 0.00E+00 | ± 25 |

D. Tritium

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total release | Ci | 4.81E+00 | 4.37E+00 | 5.19E+00 | 3.65E+00 | 1.80E+01 | ± 25 |
| 2. Average release rate | uCi/sec | 6.19E-01 | 5.56E-01 | 6.53E-01 | 4.59E-01 | 5.71E-01 | |

E. Carbon-14

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| 1. Total release | Ci | 2.78E+00 | 2.78E+00 | 2.78E+00 | 2.78E+00 | 1.11E+01 |
| 2. Average release rate | uCi/sec | 3.57E-01 | 3.53E-01 | 3.49E-01 | 3.49E-01 | 3.52E-01 |

- Indicates < MDA

TABLE 1C
INDIAN POINT 3 - CONTINUOUS GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

Nuclides Released

**1) Fission Gases**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Ar-41 | Ci | - | - | - | - | 0.00E+00 |
| Xe-133 | Ci | - | - | - | - | 0.00E+00 |
| Xe-135 | Ci | - | - | - | - | 0.00E+00 |
| Total for Period | Ci | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | **0.00E+00** |

**2) Iodines**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| I-131 | Ci | - | - | - | - | 0.00E+00 |
| I-133 | Ci | - | - | - | - | 0.00E+00 |
| I-135 | Ci | - | - | - | - | 0.00E+00 |
| Total for Period | Ci | - | - | - | - | 0.00E+00 |

**3) Particulates**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Total for Period | Ci | - | - | - | - | 0.00E+00 |

- indicates < MDA

TABLE 1C
INDIAN POINT 3 - BATCH GASEOUS EFFLUENTS
RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

Nuclides Released

**1) Fission Gases**

| | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Ar-41 | Ci | 4.23E-02 | 4.88E-02 | 4.40E-02 | 4.46E-02 | 1.80E-01 |
| Kr-85 | Ci | - | - | 9.70E-03 | - | 9.70E-03 |
| Kr-85m | Ci | - | - | - | - | 0.00E+00 |
| Kr-87 | Ci | - | - | - | - | 0.00E+00 |
| Kr-88 | Ci | - | - | - | - | 0.00E+00 |
| Xe-131m | Ci | - | - | - | - | 0.00E+00 |
| Xe-133 | Ci | 4.26E-03 | 5.41E-03 | 6.68E-03 | 5.24E-03 | 2.16E-02 |
| Xe-133m | Ci | - | - | - | - | 0.00E+00 |
| Xe-135 | Ci | - | 5.29E-07 | 2.62E-06 | - | 3.15E-06 |
| Xe-135m | Ci | - | - | - | - | 0.00E+00 |
| Total for Period | Ci | 4.65E-02 | 5.42E-02 | 6.03E-02 | 4.98E-02 | 2.11E-01 |

**2) Iodines**

Not Applicable for Batch Releases

**3) Particulates**

Not Applicable for Batch Releases

\- Indicates < MDA

Indian Point Energy Center

(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

C. LIQUID EFFLUENTS

2010

TABLE 2A

INDIAN POINT 1 and 2 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

| A. Fission & Activation Products | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 | Est. Total % Error |
|---|---|---|---|---|---|---|---|
| 1. Total Release (not including Tritium, Gr Alpha, & Gases) | Ci | 2.81E-02 | 1.60E-02 | 9.64E-03 | 2.41E-03 | 5.62E-02 | ± 25 |
| 2. Average Diluted Conc | uCi/ml | 5.99E-11 | 2.30E-11 | 1.13E-11 | 3.48E-12 | 2.07E-11 | |

B. Tritium

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 4.40E+02 | 8.19E+01 | 1.36E+02 | 7.44E+01 | 7.32E+02 | ± 25 |
| 2. Average Diluted Conc | uCi/ml | 9.37E-07 | 1.18E-07 | 1.59E-07 | 1.07E-07 | 2.70E-07 | |

C. Dissolved & Entrained Gases

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 3.64E-04 | - | - | - | 3.64E-04 | ± 25 |
| 2. AverageDiluted Conc | uCi/ml | 7.75E-13 | - | - | - | 1.34E-13 | |

D. Gross Alpha

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | - | - | - | - | 0.00E+00 | ± 25 |

E. Volume of Waste Released

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Processed Waste (LW & NCD) | liters | 4.03E+06 | 2.39E+06 | 1.67E+06 | 1.87E+06 | 9.96E+06 | ± 10 |
| 2. Unprocessed (SGBD, SFDS, U1FD) | liters | 3.92E+07 | 4.81E+07 | 3.93E+07 | 3.97E+07 | 1.66E+08 | ± 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| F. Volume of Dilution Water | liters | 4.69E+11 | 6.96E+11 | 8.55E+11 | 6.93E+11 | 2.71E+12 | ± 10 |

- Indicates < MDA

TABLE 2B

INDIAN POINT 1 and 2 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

CONTINUOUS RADIOACTIVE EFFLUENT

| Nuclides Released | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Cs-137 | Ci | 2.08E-03 | 1.49E-03 | 1.25E-03 | 1.14E-03 | 5.96E-03 |
| Ni-63 | Ci | - | - | - | - | 0.00E+00 |
| Sr-89 | Ci | - | - | - | - | 0.00E+00 |
| Sr-90 | Ci | 5.40E-04 | 2.47E-04 | 8.77E-05 | 5.09E-05 | 9.25E-04 |
| Total for Period | Ci | 2.62E-03 | 1.73E-03 | 1.34E-03 | 1.19E-03 | 6.89E-03 |

- Indicates < MDA

TABLE 2B

INDIAN POINT 1 and 2 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

BATCH RADIOACTIVE EFFLUENT

| Nuclides Released | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | Year 2010 |
|---|---|---|---|---|---|---|
| Co-57 | Ci | 1.46E-05 | - | - | - | 1.46E-05 |
| Co-58 | Ci | 4.16E-03 | 5.37E-03 | 4.22E-04 | 5.33E-05 | 1.00E-02 |
| Co-60 | Ci | 6.00E-03 | 3.50E-04 | 1.17E-05 | 1.35E-04 | 6.49E-03 |
| Cr-51 | Ci | - | 2.64E-04 | - | - | 2.64E-04 |
| Cs-137 | Ci | 2.84E-05 | 5.64E-06 | 1.88E-05 | 7.95E-06 | 6.08E-05 |
| Ni-63 | Ci | 5.67E-03 | 1.03E-03 | 5.31E-04 | 1.85E-04 | 7.42E-03 |
| Sb-124 | Ci | - | 5.73E-05 | - | | 5.73E-05 |
| Sb-125 | Ci | 6.80E-03 | 7.20E-03 | 7.32E-03 | 8.35E-04 | 2.22E-02 |
| Te-125m | Ci | 2.82E-03 | - | - | - | 2.82E-03 |
| Total for Period | Ci | 2.55E-02 | 1.43E-02 | 8.30E-03 | 1.22E-03 | **4.93E-02** |

Dissolved & Entrained Gas

| | | | | | | |
|---|---|---|---|---|---|---|
| Kr-85 | Ci | - | - | - | - | 0.00E+00 |
| Xe-133 | Ci | 3.64E-04 | - | - | - | 3.64E-04 |
| Total for Period | Ci | 3.64E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | **3.64E-04** |

- Indicates < MDA

TABLE 2A

INDIAN POINT 3 RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

| A. Fission & Activation Products | Units | **Qtr 1** | **Qtr 2** | **Qtr 3** | **Qtr 4** | **Year 2010** | Est. Total % Error |
|---|---|---|---|---|---|---|---|
| 1. Total Release (not including Tritium, Gr Alpha, & Gases) | Ci | 2.42E-03 | 2.08E-03 | 4.14E-03 | 1.92E-03 | 1.06E-02 | ± 25 |
| 2. Average Diluted Conc | uCi/ml | 5.15E-12 | 2.99E-12 | 4.84E-12 | 2.77E-12 | 3.89E-12 | |

B. Tritium

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 9.57E+00 | 8.43E+01 | 8.70E+01 | 4.77E+02 | 6.58E+02 | ± 25 |
| 2. Average Diluted Conc | uCi/ml | 2.04E-08 | 1.21E-07 | 1.02E-07 | 6.89E-07 | 2.42E-07 | |

C. Dissolved & Entrained Gases

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 3.59E-06 | 1.06E-05 | 2.24E-05 | 1.85E-04 | 2.21E-04 | ± 25 |
| 2. AverageDiluted Conc | uCi/ml | 7.64E-15 | 1.52E-14 | 2.62E-14 | 2.66E-13 | 8.15E-14 | |

D. Gross Alpha

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | - | - | - | - | 0.00E+00 | ± 25 |

E. Volume of Waste Released

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Processed Fluids (Mon Tanks) | liters | 3.06E+05 | 2.08E+05 | 4.37E+05 | 3.59E+05 | 1.31E+06 | ± 10 |
| 2. Unprocessed Fluids (SGs) | liters | 2.02E+06 | 1.62E+06 | 2.32E+06 | 7.61E+06 | 1.36E+07 | ± 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| F. Volume of Dilution Water | liters | 4.69E+11 | 6.96E+11 | 8.55E+11 | 6.93E+11 | 2.71E+12 | ± 10 |

'- indicates < MDA

TABLE 2B
INDIAN POINT 3 LIQUID RADIOACTIVE EFFLUENT REPORT (Jan - Dec 2010)
BATCH and CONTINUOUS RADIOACTIVE LIQUID EFFLUENT

| *Batch Fission/Activation Products* | Units | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | 2010 |
|---|---|---|---|---|---|---|
| Ag-110m | Ci | - | 3.49E-06 | - | - | 3.49E-06 |
| Co-58 | Ci | 1.42E-04 | 1.23E-04 | 5.69E-06 | 3.15E-05 | 3.03E-04 |
| Co-60 | Ci | 3.48E-04 | 2.18E-04 | 1.38E-04 | 1.90E-04 | 8.94E-04 |
| Cs-134 | Ci | 9.64E-05 | 1.17E-05 | 1.59E-06 | 2.02E-05 | 1.30E-04 |
| Cs-137 | Ci | 4.92E-04 | 1.24E-04 | 8.77E-05 | 2.48E-04 | 9.52E-04 |
| Ni-63 | Ci | 1.09E-03 | 1.34E-03 | 3.83E-03 | 1.25E-03 | 7.50E-03 |
| Sb-124 | Ci | - | - | - | 2.06E-06 | 2.06E-06 |
| Sb-125 | Ci | 2.48E-04 | 2.63E-04 | 8.21E-05 | 1.83E-04 | 7.75E-04 |
| Total for Period | Ci | 2.42E-03 | 2.08E-03 | 4.14E-03 | 1.92E-03 | 1.06E-02 |

*Dissolved and Entrained Gas (Batch)*

| | | | | | | |
|---|---|---|---|---|---|---|
| Xe-133 | Ci | 3.59E-06 | 1.06E-05 | 2.24E-05 | 1.85E-04 | 2.21E-04 |
| Total for Period | Ci | 3.59E-06 | 1.06E-05 | 2.24E-05 | 1.85E-04 | 2.21E-04 |

*Continuous Releases (SG Blowdown)*

| | | | | | | |
|---|---|---|---|---|---|---|
| H-3 (only) | Ci | 4.77E-03 | 5.25E-03 | 6.04E-03 | 8.79E-03 | 2.48E-02 |

'- indicates < mda

Indian Point Energy Center

(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

D. SOLID WASTE

2010

## Units 1 and 2 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2010 to 12/31/2010

Percent Cutoff: 0 (all identified isotopes are included)

Waste Stream : Resins, Filters, and Evap Bottoms — Cartidge Filters
LWS Resin — Plant Resin 8-120

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 3.25E+02 | 9.20E+00 | 2.93E+00 | +/- 25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/- 25% |
| C | 9.20E+01 | 2.61E+00 | 2.94E+02 | +/- 25% |
| All | 4.17E+02 | 1.18E+01 | 2.97E+02 | +/- 25% |

Waste Stream : Dry Active Waste — DAW / Dirt B-25 Box
DAW 20' Sea Land

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 9.02E+03 | 2.55E+02 | 2.89E-01 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 9.02E+03 | 2.55E+02 | 2.89E-01 | +/-25% |

Waste Stream : Irradiated Components

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |

Waste Stream: Other Waste — Combined Packages

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 6.80E+02 | 1.93E+01 | 1.18E+00 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 6.80E+02 | 1.93E+01 | 1.18E+00 | +/-25% |

Waste Stream : Sum of All 4 Categories — Combined Packages
DAW / Dirt B-25 Box Plant Resin 8-120 LWS Resin
DAW 20' Sea Land

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 1.00E+04 | 2.84E+02 | 4.40E+00 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 9.20E+01 | 2.61E+00 | 2.94E+02 | +/-25% |
| All | 1.01E+04 | 2.86E+02 | 2.99E+02 | +/-25% |

Combined Waste Type Shipment, Major Volume Waste Type Shown

## Units 1 and 2 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2010 to 12/31/2010

Percent Cutoff: 0

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 1 | Clean Harbors | Energy Solutions - Bear Creek |
| 5 | Hittman Transport | Energy Solutions - Bear Creek |
| 1 | Hittman Transport | Energy Solutions - GRF |
| 1 | R & R Trucking Inc | Studsvik Processing – Memphis |
| 1 | Hittman Transport | Studsvik Processing Facility |

Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream

During Period 01/01/2010 to 12/31/2010 Percent Cutoff: 0

Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.571% | 1.65E-03 |
| C-14 | 0.129% | 3.73E-04 |
| Mn-54 | 0.526% | 1.52E-03 |
| Fe-55 | 35.658% | 1.03E-01 |
| Co-58 | 10.317% | 2.98E-02 |
| Co-60 | 28.318% | 8.18E-02 |
| Ni-63 | 14.679% | 4.24E-02 |
| Sr-90 | 0.113% | 3.26E-04 |
| Zr-95 | 1.226% | 3.54E-03 |
| Nb-95 | 1.959% | 5.66E-03 |
| Ag-110m | 0.260% | 7.50E-04 |
| Sb-125 | 0.654% | 1.89E-03 |
| Cs-134 | 0.848% | 2.45E-03 |
| Cs-137 | 3.912% | 1.13E-02 |
| Ce-144 | 0.367% | 1.06E-03 |
| Pu-238 | 0.015% | 4.19E-05 |
| Pu-239 | 0.004% | 1.19E-05 |
| Pu-241 | 0.419% | 1.21E-03 |
| Am-241 | 0.005% | 1.49E-05 |
| Cm-242 | 0.001% | 2.51E-06 |
| Cm-243 | 0.020% | 5.73E-05 |

Other Waste
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.580% | 6.86E-03 |
| C-14 | 0.131% | 1.55E-03 |
| Mn-54 | 0.524% | 6.20E-03 |
| Fe-55 | 35.907% | 4.25E-01 |
| Co-58 | 9.716% | 1.15E-01 |
| Co-60 | 28.726% | 3.40E-01 |
| Ni-63 | 14.870% | 1.76E-01 |
| Sr-90 | 0.114% | 1.35E-03 |
| Zr-95 | 1.141% | 1.35E-02 |
| Nb-95 | 1.707% | 2.02E-02 |

| | | |
|---|---|---|
| Ag-110m | 0.258% | 3.05E-03 |
| Sb-125 | 0.660% | 7.81E-03 |
| Cs-134 | 0.853% | 1.01E-02 |
| Cs-137 | 3.979% | 4.71E-02 |
| Ce-144 | 0.366% | 4.33E-03 |
| Pu-238 | 0.015% | 1.75E-04 |
| Pu-239 | 0.004% | 4.97E-05 |
| Pu-241 | 0.425% | 5.03E-03 |
| Am-241 | 0.005% | 6.21E-05 |
| Cm-242 | 0.001% | 1.01E-05 |
| Cm-243 | 0.020% | 2.38E-04 |

Other Waste
Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.580% | 6.86E-03 |
| C-14 | 0.131% | 1.55E-03 |
| Mn-54 | 0.524% | 6.20E-03 |
| Fe-55 | 35.907% | 4.25E-01 |
| Co-58 | 9.716% | 1.15E-01 |
| Co-60 | 28.726% | 3.40E-01 |
| Ni-63 | 14.870% | 1.76E-01 |
| Sr-90 | 0.114% | 1.35E-03 |
| Zr-95 | 1.141% | 1.35E-02 |
| Nb-95 | 1.707% | 2.02E-02 |
| Ag-110m | 0.258% | 3.05E-03 |
| Sb-125 | 0.660% | 7.81E-03 |
| Cs-134 | 0.853% | 1.01E-02 |
| Cs-137 | 3.979% | 4.71E-02 |
| Ce-144 | 0.366% | 4.33E-03 |
| Pu-238 | 0.015% | 1.75E-04 |
| Pu-239 | 0.004% | 4.97E-05 |
| Pu-241 | 0.425% | 5.03E-03 |
| Am-241 | 0.005% | 6.21E-05 |
| Cm-242 | 0.001% | 1.01E-05 |
| Cm-243 | 0.020% | 2.38E-04 |

Sum of All 4 Categories
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.221% | 9.76E-03 |
| C-14 | 0.044% | 1.93E-03 |
| Mn-54 | 0.451% | 1.99E-02 |
| Fe-55 | 23.582% | 1.04E+00 |
| Co-57 | 0.081% | 3.59E-03 |
| Co-58 | 13.174% | 5.81E-01 |
| Co-60 | 13.651% | 6.02E-01 |
| Ni-63 | 20.136% | 8.88E-01 |
| Sr-90 | 0.073% | 3.24E-03 |
| Zr-95 | 0.388% | 1.71E-02 |
| Nb-95 | 0.587% | 2.59E-02 |
| Ag-110m | 0.086% | 3.80E-03 |
| Sb-124 | 0.051% | 2.26E-03 |

| | | |
|---|---|---|
| Sb-125 | 1.730% | 7.63E-02 |
| Cs-134 | 4.104% | 1.81E-01 |
| Cs-137 | 21.360% | 9.42E-01 |
| Ce-144 | 0.122% | 5.39E-03 |
| Pu-238 | 0.005% | 2.16E-04 |
| Pu-239 | 0.001% | 6.17E-05 |
| Pu-241 | 0.141% | 6.24E-03 |
| Am-241 | 0.002% | 7.70E-05 |
| Cm-242 | 0.000% | 1.26E-05 |
| Cm-243 | 0.007% | 2.96E-04 |

Sum of All 4 Categories
Waste Class C

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.043% | 1.27E-01 |
| Mn-54 | 0.041% | 1.19E-01 |
| Fe-55 | 1.021% | 3.00E+00 |
| Co-57 | 0.044% | 1.28E-01 |
| Co-60 | 8.648% | 2.54E+01 |
| Ni-63 | 60.262% | 1.77E+02 |
| Sr-89 | 0.010% | 3.06E-02 |
| Sr-90 | 0.238% | 6.99E-01 |
| Sb-125 | 0.848% | 2.49E+00 |
| Cs-134 | 6.367% | 1.87E+01 |
| Cs-137 | 22.266% | 6.54E+01 |
| Ce-144 | 0.145% | 4.25E-01 |
| Pu-238 | 0.003% | 7.60E-03 |
| Pu-239 | 0.001% | 1.59E-03 |
| Pu-241 | 0.063% | 1.84E-01 |
| Am-241 | 0.000% | 1.02E-03 |
| Cm-242 | 0.000% | 2.92E-04 |
| Cm-243 | 0.001% | 4.07E-03 |

Sum of All 4 Categories
Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.046% | 1.37E-01 |
| C-14 | 0.001% | 1.93E-03 |
| Mn-54 | 0.047% | 1.39E-01 |
| Fe-55 | 1.351% | 4.03E+00 |
| Co-57 | 0.044% | 1.31E-01 |
| Co-58 | 0.195% | 5.81E-01 |
| Co-60 | 8.719% | 2.60E+01 |
| Ni-63 | 59.690% | 1.78E+02 |
| Sr-89 | 0.010% | 3.06E-02 |
| Sr-90 | 0.235% | 7.02E-01 |
| Zr-95 | 0.006% | 1.71E-02 |
| Nb-95 | 0.009% | 2.59E-02 |
| Ag-110m | 0.001% | 3.80E-03 |
| Sb-124 | 0.001% | 2.26E-03 |
| Sb-125 | 0.862% | 2.57E+00 |
| Cs-134 | 6.338% | 1.89E+01 |
| Cs-137 | 22.233% | 6.63E+01 |

| | | |
|---|---|---|
| Ce-144 | 0.144% | 4.30E-01 |
| Pu-238 | 0.003% | 7.82E-03 |
| Pu-239 | 0.001% | 1.65E-03 |
| Pu-241 | 0.064% | 1.90E-01 |
| Am-241 | 0.000% | 1.09E-03 |
| Cm-242 | 0.000% | 3.05E-04 |
| Cm-243 | 0.001% | 4.36E-03 |

Resins, Filters, and Evap Bottoms
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.043% | 1.25E-03 |
| Mn-54 | 0.416% | 1.22E-02 |
| Fe-55 | 17.380% | 5.10E-01 |
| Co-57 | 0.122% | 3.59E-03 |
| Co-58 | 14.858% | 4.36E-01 |
| Co-60 | 6.134% | 1.80E-01 |
| Ni-63 | 22.798% | 6.69E-01 |
| Sr-90 | 0.053% | 1.56E-03 |
| Sb-124 | 0.077% | 2.26E-03 |
| Sb-125 | 2.270% | 6.66E-02 |
| Cs-134 | 5.725% | 1.68E-01 |
| Cs-137 | 30.125% | 8.84E-01 |

Resins, Filters, and Evap Bottoms
Waste Class C

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.043% | 1.27E-01 |
| Mn-54 | 0.041% | 1.19E-01 |
| Fe-55 | 1.021% | 3.00E+00 |
| Co-57 | 0.044% | 1.28E-01 |
| Co-60 | 8.648% | 2.54E+01 |
| Ni-63 | 60.262% | 1.77E+02 |
| Sr-89 | 0.010% | 3.06E-02 |
| Sr-90 | 0.238% | 6.99E-01 |
| Sb-125 | 0.848% | 2.49E+00 |
| Cs-134 | 6.367% | 1.87E+01 |
| Cs-137 | 22.266% | 6.54E+01 |
| Ce-144 | 0.145% | 4.25E-01 |
| Pu-238 | 0.003% | 7.60E-03 |
| Pu-239 | 0.001% | 1.59E-03 |
| Pu-241 | 0.063% | 1.84E-01 |
| Am-241 | 0.000% | 1.02E-03 |
| Cm-242 | 0.000% | 2.92E-04 |
| Cm-243 | 0.001% | 4.07E-03 |

Resins, Filters, and Evap Bottoms
Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.044% | 1.29E-01 |
| Mn-54 | 0.045% | 1.32E-01 |
| Fe-55 | 1.186% | 3.51E+00 |
| Co-57 | 0.044% | 1.31E-01 |
| Co-58 | 0.147% | 4.36E-01 |
| Co-60 | 8.619% | 2.55E+01 |
| Ni-63 | 59.827% | 1.77E+02 |
| Sr-89 | 0.010% | 3.06E-02 |
| Sr-90 | 0.237% | 7.00E-01 |
| Sb-124 | 0.001% | 2.26E-03 |
| Sb-125 | 0.865% | 2.56E+00 |
| Cs-134 | 6.354% | 1.88E+01 |
| Cs-137 | 22.410% | 6.63E+01 |
| Ce-144 | 0.144% | 4.25E-01 |
| Pu-238 | 0.003% | 7.60E-03 |
| Pu-239 | 0.001% | 1.59E-03 |
| Pu-241 | 0.062% | 1.84E-01 |
| Am-241 | 0.000% | 1.02E-03 |
| Cm-242 | 0.000% | 2.92E-04 |
| Cm-243 | 0.001% | 4.07E-03 |

Dry Active Waste
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.571% | 1.65E-03 |
| C-14 | 0.129% | 3.73E-04 |
| Mn-54 | 0.526% | 1.52E-03 |
| Fe-55 | 35.658% | 1.03E-01 |
| Co-58 | 10.317% | 2.98E-02 |
| Co-60 | 28.318% | 8.18E-02 |
| Ni-63 | 14.679% | 4.24E-02 |
| Sr-90 | 0.113% | 3.26E-04 |
| Zr-95 | 1.226% | 3.54E-03 |
| Nb-95 | 1.959% | 5.66E-03 |
| Ag-110m | 0.260% | 7.50E-04 |
| Sb-125 | 0.654% | 1.89E-03 |
| Cs-134 | 0.848% | 2.45E-03 |
| Cs-137 | 3.912% | 1.13E-02 |
| Ce-144 | 0.367% | 1.06E-03 |
| Pu-238 | 0.015% | 4.19E-05 |
| Pu-239 | 0.004% | 1.19E-05 |
| Pu-241 | 0.419% | 1.21E-03 |
| Am-241 | 0.005% | 1.49E-05 |
| Cm-242 | 0.001% | 2.51E-06 |
| Cm-243 | 0.020% | 5.73E-05 |

# Unit 3 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2010 to 12/31/2010

Percent Cutoff: 0 (all identified isotopes are included)

Waste Stream : Resins, Filters, and Evap Bottoms .

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/- 25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/- 25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/- 25% |
| All | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/- 25% |

Waste Stream : Dry Active Waste U3 DAW B-25
Unit 3 DAW-20' Sealand 20' Intermodal Soil

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 1.38E+04 | 3.92E+02 | 9.10E-02 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 1.38E+04 | 3.92E+02 | 9.10E-02 | +/-25% |

Waste Stream : Irradiated Components

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |

Waste Stream : Other Waste Combined Packages

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |

Waste Stream : Sum of All 4 Categories
Unit3 DAW B-25 20' Intermodal Soil DAW 20' Shielded SeaLand

| Waste Class | Volume ft³ | Volume m³ | Curies Shipped | % Error (Ci) |
|---|---|---|---|---|
| A | 1.38E+04 | 3.92E+02 | 9.10E-02 | +/-25% |
| B | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 | +/-25% |
| All | 1.38E+04 | 3.92E+02 | 9.10E-02 | +/-25% |

Combined Waste Type Shipment, Major Volume Waste Type Shown

# Unit 3 Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream 01/01/2010 to 12/31/2010

Percent Cutoff: 0

| Number of Shipments | Mode of Transportation | Destination |
|---|---|---|
| 1 | Tri State Motor Transit | Energy Solutions Bear Creek |
| 1 | Hittman Transport | Studsvik Processing – Memphis |
| 22 | R & R Trucking Inc | Studsvik Processing – Memphis |

Solid Waste Shipped Offsite for Disposal and Estimates of Major Nuclides by Waste Class and Stream

During Period 01/01/2010 to 12/31/2010 Percent Cutoff: 0

Dry Active Waste
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.363% | 3.30E-04 |
| Mn-54 | 0.267% | 2.43E-04 |
| Fe-55 | 22.193% | 2.02E-02 |
| Co-58 | 0.026% | 2.39E-05 |
| Co-60 | 18.787% | 1.71E-02 |
| Ni-63 | 13.843% | 1.26E-02 |
| Sr-90 | 0.012% | 1.09E-05 |
| Cs-134 | 0.123% | 1.12E-04 |
| Cs-137 | 44.386% | 4.04E-02 |

Dry Active Waste
Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.363% | 3.30E-04 |
| Mn-54 | 0.267% | 2.43E-04 |
| Fe-55 | 22.193% | 2.02E-02 |
| Co-58 | 0.026% | 2.39E-05 |
| Co-60 | 18.787% | 1.71E-02 |
| Ni-63 | 13.843% | 1.26E-02 |
| Sr-90 | 0.012% | 1.09E-05 |
| Cs-134 | 0.123% | 1.12E-04 |
| Cs-137 | 44.386% | 4.04E-02 |

Sum of All 4 Categories
Waste Class A

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.363% | 3.30E-04 |
| Mn-54 | 0.267% | 2.43E-04 |
| Fe-55 | 22.193% | 2.02E-02 |
| Co-58 | 0.026% | 2.39E-05 |
| Co-60 | 18.787% | 1.71E-02 |
| Ni-63 | 13.843% | 1.26E-02 |
| Sr-90 | 0.012% | 1.09E-05 |
| Cs-134 | 0.123% | 1.12E-04 |
| Cs-137 | 44.386% | 4.04E-02 |

Sum of All 4 Categories
Waste Class All

| Nuclide Name | Percent Abundance | Curies |
|---|---|---|
| H-3 | 0.363% | 3.30E-04 |
| Mn-54 | 0.267% | 2.43E-04 |
| Fe-55 | 22.193% | 2.02E-02 |
| Co-58 | 0.026% | 2.39E-05 |
| Co-60 | 18.787% | 1.71E-02 |
| Ni-63 | 13.843% | 1.26E-02 |
| Sr-90 | 0.012% | 1.09E-05 |
| Cs-134 | 0.123% | 1.12E-04 |
| Cs-137 | 44.386% | 4.04E-02 |

Indian Point Energy Center
(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

E. RADIOLOGICAL IMPACT ON MAN

Jan 1, 2010 - Dec 31, 2010

# RADIOLOGICAL IMPACT ON MAN

## Routine Effluent Dose Calculations:

The Radiological Impact on Man due to radioactive effluent from the site is determined from NRC approved modeling, per Reg Guide 1.109 and NUREG 0133. Calculations are divided into 3 categories: Noble Gases, Particulates and Iodine, and Liquid Releases (fish and invertebrate consumption). This modeling involves conservative dose calculations to Adult, Teen, Child, and Infant age groups. Furthermore, dose modeling is performed for six separate organs as well as the total body dose. This well-established industry model provides doses (as a result of plant effluent) to a hypothetical maximally exposed individual offsite. While ALL age groups and organs are considered, it is this ***maximum value*** that is provided in the tables that follow.

An approved computer code is used to perform liquid and gaseous dose calculations according to the models and parameters presented in the Indian Point Offsite Dose Calculation Manual (ODCM). This information is stored in a database on site to enhance dose tracking information and management. Site airborne effluent dose calculations include annual average dispersion and deposition factors, averaged from data collected over approximate ten year periods. When new data is averaged (approximately every ten years) the modeling is updated and used in subsequent airborne effluent calculations.

Liquid offsite dose calculations involve fish and invertebrate consumption pathways only, as determined in the ODCM. While the ODCM identified some site-specific dose factors, the bulk of this information is obtained directly from Regulatory Guide 1.109 and NUREG 0133. Details of the calculations, site-specific data, and their bases are presented in the ODCM.

## Carbon-14 (C-14):

Concentrations and offsite dose from C-14 were determined from sampling at Indian Point #3 from August 1980 to June 1982, during a study conducted by the NY State Department of Health (C. Kunz, later published and incorporated into NCRP 81). The annual C-14 curies released, as determined from this study, were consistent with NUREG 0017, Rev. 1. Data was then normalized to a maximum expected annual total, based on rated electrical capacity, (approximately 1000 MW(e) maintained for the entire year). Dose calculations were performed on the fraction of C-14 determined to be in the Carbon Dioxide form (26%), as no dose to man is expected from other forms (methane, etc). Reg Guide 1.109 methodology was applied to determine the offsite maximum dose, per the ODCM. For a single unit, the following data was reported from1984-2004, based on the measurements at IP#3 (Kunz, 1983):

- 0.07 curies released in liquid form
- 9.6 curies per year total C-14 released in airborne form (normalized to 100% power)
- 26% of the airborne C-14 was $CO_2$, or 2.5 curies per unit affecting offsite dose

| | Liquid Dose, Child mrem | Airborne Dose, Child mrem |
|---|---|---|
| IP3 Critical Organ (Bone) Dose | **5.83E-3** | **2.54E-1** |
| IP3 Total Body Dose | **1.17E-3** | **5.08E-2** |

In 2004, Indian Point was consolidated as Indian Point Energy Center (IPEC), Units 1, 2, & 3. The operating units (2 and 3) are very similar, so C-14 values reported at Unit 3 were doubled for the corrected site totals in reports through 2009. However, after June 2009, an effort was initiated within the industry to better characterize and report C-14 airborne effluent.

In 2010, IPEC and other facilities participated in an EPRI task force to build a model to accurately estimate C-14 releases, given some key site-specific plant parameters (mass of the primary coolant, average thermal neutron cross section, rated MW, etc). This work was completed in November 2010. The estimates from this model, for IPEC, closely match the measured observations of 1982 (the new model results in an increase in estimated curies by approximately 8%). For purposes of industry standardization, this report uses the output from the EPRI model. The maximum C-14 curies and dose for a year's operation are shown below:

| **Maximum** (Bounding) Annual C-14 releases from IPEC | | **Unit 2** | **Unit 3** |
|---|---|---|---|
| Liquid Effluent $C^{14}$ Released | Curies | **0.07** | **0.07** |
| Total Airborne $C^{14}$ Released | Curies | **11.19** | **11.05** |
| Airborne $C^{14}$ as $CO_2$ | Curies | **2.91** | **2.87** |

| | | | |
|---|---|---|---|
| Airborne Eff Child TB Dose, $C^{14}$ | mrem | **0.0690** | **0.0675** |
| Airborne Eff Child Bone Dose, $C^{14}$ | mrem | **0.346** | **0.338** |
| Liquid Eff Child TB Dose, $C^{14}$ | mrem | **0.00117** | **0.00116** |
| Liquid Eff Child Bone Dose, $C^{14}$ | mrem | **0.00583** | **0.00577** |

These bounding values are then normalized with actual effective full power days (EFFD) to yield annual curies and mrem for each unit, for each reporting year. Tables 1A (shown earlier) include the curie data. Doses are shown in the Radiological Impact on Man section, following this discussion. In each case, calculated annual totals were simply divided by four to estimate the quarterly contribution. Future reports may refine this methodology as we continue to evaluate improvements in C-14 measurement and reporting.

C-14 doses are grouped with "Iodine and Particulate" and reported in Table D in the following Radiological Impact on Man tables, for each unit. Table "C" provides doses from this category *excluding* C-14, for information and comparison purposes only. Table "D" includes dose from all categories of this group (Iodine, Particulate, Tritium, and Carbon-14).

**Members of the Public:**

Members of the public visiting the site receive minimal dose as a result of airborne and liquid releases because of the relatively insignificant total amount of time they are on site, as well as the immeasurably low levels of dose at the critical receptors. Their doses can be calculated from standard ODCM methodology, with typical occupancy factors employed. These factors are determined by comparing a conservative assumption for their expected hours on site, to 8760 hours (the number of hours in a year, used in calculations in the ODCM).

example 1: Several students visit the site for an 8-hour guided tour.
Their occupancy factor is: 8 / 8760 or **.0009**.

example 2: A man drives his wife to work and drops her off at the security gate each morning, with a total stay-time on site for 2 minutes per day. His occupancy factor is calculated as follows:
2 min/60 min per hour =.0333 hr; 0.0333 / 8760 = **3.8E-6**

These factors, when multiplied by doses calculated per the ODCM, demonstrate that dose to MEMBERS OF THE PUBLIC within the site boundary is negligible, despite a potential reduction in the atmospheric dispersion.

**Groundwater:**

Curies and dose contribution from activity discovered in onsite ground water and storm drain pathways during the year are discussed in detail in Section H. The offsite dose calculation involves multiple source term measurements, as well as determinations for release and dilution flow. A summary of the quantification methodology, and the resulting calculated doses, is provided at the end of Section H. The Total Dose table below provides a means to compare ground water doses with those of other components making up the site's total dose.

**Total Dose:**

Unit and pathway-specific dose data can be found on the Radiological Impact on Man tables following this discussion. For simplicity and to demonstrate compliance with 40CFR190, the following table indicates the maximum hypothetical Total Dose to an individual from operation of the facility, including any measured direct shine component from the site property for 2010:

| | | Whole Body | Max Organ |
|---|---|---|---|
| **40 CFR 190 limit ===➔** | **IPEC** | **25 mrem** | **75 mrem** |
| Routine Airborne Effluents[1] | Units 1 and 2 | 0.00276 | 0.00276 |
| Routine Liquid Effluents | Units 1 and 2 | 0.000518 | 0.00109 |
| Liquid Releases of $C^{14}$ | Units 1 and 2 | 0.00117 | 0.00583 |
| Airborne Releases of $C^{14}$ | Units 1 and 2 | 0.0566 | 0.284 |
| Routine Airborne Effluents[1] | Unit 3 | 0.00508 | 0.00508 |
| Routine Liquid Effluents | Unit 3 | 0.000170 | 0.000973 |
| Liquid Releases of $C^{14}$ | Unit 3 | 0.00117 | 0.00583 |
| Airborne Releases of $C^{14}$ | Unit 3 | 0.0665 | 0.333 |
| **Ground Water & Storm Drain Totals** | **IPEC[2]** | **0.000173** | **0.000706** |
| **Direct Shine from areas such as dry cask storage, radwaste storage, SG Mausoleum, etc.** | **IPEC[3]** | **0.061** | **0.061** |
| **Indian Point Energy Center Total Dose, per 40 CFR 190** | **IPEC** | **0.195** | **0.700** |

Note 1: Routine airborne dose in this table is conservatively represented as a sum of Iodine, Particulate, and Tritium dose (excluding C-14, in mrem) with a mrem term added from noble gas beta air energy (mrad, expressed as mrem). This 'addition' does not represent a real dose and is listed here solely to help demonstrate compliance with 40CFR190. (Doses by type of release and comparison to the specific limits of 10CFR50 Appendix I are summarized on the following pages.)

Note 2: Groundwater curie and dose calculations are provided in Section H.

Note 3: 40CFR190 requires the reporting of total dose, including that of direct shine. Direct shine dose from sources other than dry cask are indistinguishable from background. Direct shine dose is determined from TLDs near the dry cask area and site boundary, compared with REMP TLDs and historical values, and corrected with occupancy factors to determine a bounding, worst case assessment of direct shine dose to a real individual. Details of this evaluation are available on site from Radiation Protection.

INDIAN POINT UNITS 1 and 2 NUCLEAR POWER PLANTS
RADIOLOGICAL IMPACT ON MAN
JANUARY - DECEMBER 2010

Maximum exposed individual doses in mrem or mrad

A. LIQUID DOSES

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Organ Dose | (mrem) | 7.41E-04 | 1.86E-04 | 8.87E-05 | 7.62E-05 | **1.09E-03** |
| Applicable Limit | (mrem) | 5 | 5 | 5 | 5 | 10 |
| Percent of Limit | (%) | 1.48E-02 | 3.72E-03 | 1.77E-03 | 1.52E-03 | 1.09E-02 |
| Age Group | | Child | Child | Child | Child | Child |
| Critical Organ | | Bone | Bone | Bone | Bone | Bone |

| | | | | | | |
|---|---|---|---|---|---|---|
| Adult Total Body | (mrem) | 3.16E-04 | 8.88E-05 | 5.90E-05 | 5.38E-05 | **5.18E-04** |
| Applicable Limit | (mrem) | 1.5 | 1.5 | 1.5 | 1.5 | 3.0 |
| Percent of Limit | (%) | 2.11E-02 | 5.92E-03 | 3.93E-03 | 3.59E-03 | 1.73E-02 |

B. AIRBORNE NOBLE GAS DOSES

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Gamma Air | (mrad) | 6.72E-05 | 5.71E-06 | 1.83E-05 | 8.66E-06 | **9.99E-05** |
| Applicable Limit | (mrad) | 5 | 5 | 5 | 5 | 10 |
| Percent of Limit | (%) | 1.34E-03 | 1.14E-04 | 3.66E-04 | 1.73E-04 | 9.99E-04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Beta Air | (mrad) | 1.30E-04 | 5.21E-06 | 1.65E-05 | 6.29E-06 | **1.58E-04** |
| Applicable Limit | (mrad) | 10 | 10 | 10 | 10 | 20 |
| Percent of Limit | (%) | 1.30E-03 | 5.21E-05 | 1.65E-04 | 6.29E-05 | 7.90E-04 |

C. AIRBORNE IODINE, PARTICULATE, & TRITIUM DOSES (excluding C-14, for info only)

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Iodine/Part | (mrem) | 4.74E-04 | 4.32E-04 | 1.21E-03 | 4.81E-04 | **2.60E-03** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 6.32E-03 | 5.76E-03 | 1.61E-02 | 6.41E-03 | 1.73E-02 |
| Age Group | | Child | Child | Child | Child | Child |
| Critical Organ | | Liver | Liver | Liver | Liver | Liver |

D. AIRBORNE IODINE, PARTICULATE, TRITIUM, and CARBON-14 DOSES

| | | | | | | |
|---|---|---|---|---|---|---|
| Total Body Dose | (mrem) | 1.42E-02 | 1.42E-02 | 1.42E-02 | 1.42E-02 | **5.66E-02** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 1.89E-01 | 1.89E-01 | 1.89E-01 | 1.89E-01 | 3.77E-01 |
| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
| Child Bone Dose | (mrem) | 7.10E-02 | 7.10E-02 | 7.10E-02 | 7.10E-02 | **2.84E-01** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 9.47E-01 | 9.47E-01 | 9.47E-01 | 9.47E-01 | 1.89E+00 |

INDIAN POINT 3 NUCLEAR POWER PLANT
RADIOLOGICAL IMPACT ON MAN
JANUARY - DECEMBER 2010

Maximum exposed individual doses in mrem or mrad

### A. LIQUID DOSES

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Organ Dose | (mrem) | 1.06E-04 | 6.35E-05 | 1.39E-04 | 1.01E-04 | **9.73E-04** |
| Applicable Limit | (mrem) | 5 | 5 | 5 | 5 | 10 |
| Percent of Limit | (%) | 2.12E-03 | 1.27E-03 | 2.78E-03 | 2.02E-03 | 9.73E-03 |
| Age Group | | Child | Child | Child | Adult | Child |
| Critical Organ | | Bone | Bone | Bone | Liver | Bone |

| | | | | | | |
|---|---|---|---|---|---|---|
| Adult Total Body | (mrem) | 3.40E-05 | 2.11E-05 | 1.84E-05 | 9.61E-05 | **1.70E-04** |
| Applicable Limit | (mrem) | 1.5 | 1.5 | 1.5 | 1.5 | 3.0 |
| Percent of Limit | (%) | 2.27E-03 | 1.41E-03 | 1.23E-03 | 6.41E-03 | 5.65E-03 |

### B. AIRBORNE NOBLE GAS DOSES

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Gamma Air | (mrad) | 1.20E-05 | 1.39E-05 | 1.26E-05 | 1.27E-05 | **5.12E-05** |
| Applicable Limit | (mrad) | 5 | 5 | 5 | 5 | 10 |
| Percent of Limit | (%) | 2.40E-04 | 2.78E-04 | 2.52E-04 | 2.54E-04 | 5.12E-04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Beta Air | (mrad) | 2.03E-05 | 2.35E-05 | 2.41E-05 | 2.15E-05 | **8.94E-05** |
| Applicable Limit | (mrad) | 10 | 10 | 10 | 10 | 20 |
| Percent of Limit | (%) | 2.03E-04 | 2.35E-04 | 2.41E-04 | 2.15E-04 | 4.47E-04 |

### C. AIRBORNE IODINE, PARTICULATE, & TRITIUM DOSES (excluding C-14, for info only)

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Iodine/Part | (mrem) | 7.95E-04 | 1.18E-03 | 1.64E-03 | 1.37E-03 | **4.99E-03** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 1.06E-02 | 1.57E-02 | 2.19E-02 | 1.83E-02 | 3.32E-02 |
| Age Group | | Child | Child | Child | Child | Child |
| Critical Organ | | Liver | Liver | Liver | Liver | Liver |

### D. AIRBORNE IODINE, PARTICULATE, TRITIUM, and CARBON-14 DOSES

| | | | | | | |
|---|---|---|---|---|---|---|
| Total Body Dose | (mrem) | 1.69E-02 | 1.69E-02 | 1.69E-02 | 1.69E-02 | **6.75E-02** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 2.25E-01 | 2.25E-01 | 2.25E-01 | 2.25E-01 | 4.50E-01 |

| | | Qtr 1 | Qtr 2 | Qtr 3 | Qtr 4 | ANNUAL |
|---|---|---|---|---|---|---|
| Child Bone Dose | (mrem) | 8.45E-02 | 8.45E-02 | 8.45E-02 | 8.45E-02 | **3.38E-01** |
| Applicable Limit | (mrem) | 7.5 | 7.5 | 7.5 | 7.5 | 15 |
| Percent of Limit | (%) | 1.13E+00 | 1.13E+00 | 1.13E+00 | 1.13E+00 | 2.25E+00 |

Indian Point Energy Center
(Units 1, 2, and 3)

RADIOLOGICAL EFFLUENT REPORT

F. METEOROLOGICAL DATA

Jan 1, 2010 - Dec 31, 2010

This data is stored onsite and is available in printed or electronic form.

Indian Point Energy Center
(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

G. OFFSITE DOSE CALCULATION MANUAL, REMP SAMPLING LOCATIONS, PROCESS CONTROL PROGRAM, OR LAND USE CENSUS LOCATION CHANGES

2010

**There were no changes to the ODCM, REMP, or PCP in 2010.**

**There were no changes to the Land Use Census in year 2010.**

Indian Point Energy Center
(Units 1, 2, and 3)

RADIOACTIVE EFFLUENT REPORT

H. GROUNDWATER and STORM WATER REPORT

ACTIVITY ON SITE and OFFSITE DOSE CALCULATION

FOR THE PERIOD:

Jan 1, 2010 - Dec 31, 2010

# Summary of IPEC Groundwater and Storm Water Activity, 2010

The Unit 1 Spent Fuel, which had been considered the source of most of the groundwater contamination, was removed in 2008, to integrated spent fuel storage. This process demanded pool levels to be increased in April, 2008, for the defueling operation. During this evolution, the pool water was continuously demineralized and carefully monitored. After defueling, the pools were further processed with additional cleanup. For dewatering, two sets of composite samplers were installed, and the slow, permitted release was carefully integrated. Resin-specific cleanup systems were added during the pump down to the routine liquid effluent release line. The empty pools were then cleaned, closed, and covered.

As a result of aggressive processing before, during, and after the defueling operation, the effluent release from draining the pools (Sep, 2008) resulted in curies and mrem consistent with or slightly lower than routine monthly effluent. Stontium-90 releases, in particular, were essentially non-existent, because the pool water had been cleaned up for months prior draining.

Because the pool levels had to be increased for a time in 2008 (as mentioned above), some increases in groundwater contamination were expected through 2009. Wells near the Unit 1 pools did in fact start to show somewhat elevated activity in 2009, but by the end of the year, a clear downward trend was visible. Monitored Natural Attenuation continues to be evident through 2010 as curie and dose values continue to decline.

The precipitation mass balance model applied in 2007 through 2009 was applied for offsite dose calculations in 2010, with some minor calibration updates performed by the contractor with regard to the distribution of groundwater flow through the site. Groundwater elevation readings continued to validate the model throughout the year. The USGS, as well as IPEC local MET data verified annual precipitation averaging approximately 3 feet per year.

**Results of 2010 Groundwater and Storm water offsite dose evaluation**

The results of the assessment are shown on the following table. These dose values are again a small portion of the annual limits (<0.01%), and were added to the Total Dose table in the opening summary of the Dose to Man section of this report (Section E).

Based on the above analysis, the total GW and storm water Tritium released from IPEC was approximately 0.12 Curies in 2010, resulting in a total body dose of significantly less than 0.1 mrem (1.9E-7 mrem). It is evident that tritium alone, whether from ground water or routine effluents, does not arithmetically contribute to integrated offsite dose.

While trace levels of Co-60, Cs-137, and Ni-63 were identified in a few upstream wells in 2010, sampling near the effluent points identified only trace levels of Tritium and Strontium-90 during the year, indicating continued reduction through natural attenuation. Sr-90, a legacy isotope from Unit 1, contributed approximately 0.000042 curies to site effluent from the groundwater pathway. Combined groundwater releases from IPEC in 2010 (all radionuclides) resulted in a calculated annual dose of less than 0.01% of the annual limits for whole body and critical organ:

<u>IPEC Groundwater and Storm Water Effluent Dose, 2010</u>

| | |
|---|---|
| 0.000173 mrem to the total body, | (0.00578% limit) |
| 0.000706 mrem to the critical organ, adult bone | (0.00706% limit) |

The annual dose from combined groundwater and storm water pathways remains well below applicable limits. When combined with routine liquid effluents, the total dose also remains significantly below ALARA limits of 3 mrem total body, and 10 mrem to the critical organ.

**IPEC Summary for Storm & Ground Water releases (H-3, Co-60, Ni-63, Sr-90, and Cs-137)**

2010
*year*

**Northern Clean Zone** Adult Doses,in mrem

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 3.64E+02 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 0.00E+00 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 4.08E-09 | 3.64E+02 |

**Unit 2 North**

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 5.96E+04 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 0.00E+00 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 1.66E-08 | 5.96E+04 |

**Unit 1/2**

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 6.62E-08 | 6.62E-08 | 6.62E-08 | 6.62E-08 | 6.62E-08 | 6.62E-08 | 1.23E+04 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 4.16E-04 | 0.00E+00 | 1.02E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.20E-05 | 3.07E+01 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 4.16E-04 | 6.62E-08 | 1.02E-04 | 6.62E-08 | 6.62E-08 | 6.62E-08 | 1.21E-05 | 1.24E+04 |

**Unit 3 North**

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 3.11E-08 | 3.11E-08 | 3.11E-08 | 3.11E-08 | 3.11E-08 | 3.11E-08 | 3.70E+03 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 1.11E-04 | 0.00E+00 | 2.72E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.19E-06 | 4.42E+00 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 1.11E-04 | 3.11E-08 | 2.72E-05 | 3.11E-08 | 3.11E-08 | 3.11E-08 | 3.22E-06 | 3.70E+03 |

**Unit 3 South**

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 2.38E-08 | 2.38E-08 | 2.38E-08 | 2.38E-08 | 2.38E-08 | 2.38E-08 | 2.60E+04 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 1.79E-04 | 0.00E+00 | 4.40E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.16E-06 | 7.15E+00 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 1.79E-04 | 2.38E-08 | 4.40E-05 | 2.38E-08 | 2.38E-08 | 2.38E-08 | 5.19E-06 | 2.60E+04 |

**Southern Clean Zone**

| ISOTOPE | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI | uCi |
|---|---|---|---|---|---|---|---|---|
| H-3 | 0.00E+00 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 1.57E+04 |
| Co-60 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ni-63 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Sr-90 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cs-137 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| totals | 0.00E+00 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 4.68E-08 | 1.57E+04 |

**Totals:** Adult Doses, in mrem

| | BONE | LIVER | TOT BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|
| H-3 only | 0.00E+00 | 1.89E-07 | 1.89E-07 | 1.89E-07 | 1.89E-07 | 1.89E-07 | 1.89E-07 |
| all isotopes | **7.06E-04** | 1.89E-07 | **1.73E-04** | 1.89E-07 | 1.89E-07 | 1.89E-07 | 2.05E-05 |
| **Adult Doses** | | | | | | | |
| **% Annual Limit** | *0.00706* | *0.000* | *0.00578* | *0.000* | *0.000* | *0.000* | *0.000* |

| Total uCis | |
|---|---|
| 1.18E+05 | H3 |
| 0.00E+00 | Co |
| 0.00E+00 | Ni |
| 4.23E+01 | Sr |
| 0.00E+00 | Cs |

# INDIAN POINT
# RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

2010

## Summary of Results

The following pages represent a summary of isotopic radio-analytical data for all onsite groundwater testing performed at Indian Point in 2010, as required per the ODCM and NEI 07-07.

Tritium and Strontium were the only isotopes identified in Groundwater in 2010.

## Tritium Summary



| Well Name | # Samples in 2010 | # Positive Samples in 2010 | Ave Pos Act | Min Pos Act | Max Pos Act |
|---|---|---|---|---|---|
| B-1 | 4 | 4 | 4.67E+03 | 8.15E+02 | 1.40E+04 |
| B-6 | 4 | 1 | 3.78E+02 | 3.78E+02 | 3.78E+02 |
| I-2 | 2 | 1 | 1.74E+02 | 1.74E+02 | 1.74E+02 |
| MH-5 | 6 | 6 | 2.11E+03 | 2.08E+02 | 9.96E+03 |
| MW-111 | 5 | 5 | 3.82E+04 | 2.63E+04 | 4.69E+04 |
| MW-30-69 | 8 | 8 | 1.33E+05 | 1.11E+05 | 1.61E+05 |
| MW-30-84 | 8 | 8 | 9.01E+03 | 6.60E+03 | 1.02E+04 |
| MW-31-49 | 8 | 8 | 2.83E+04 | 4.46E+02 | 1.04E+05 |
| MW-31-63 | 8 | 8 | 4.77E+04 | 1.84E+04 | 7.35E+04 |
| MW-31-85 | 8 | 8 | 7.93E+03 | 2.69E+03 | 2.25E+04 |
| MW-32-149 | 7 | 7 | 4.53E+03 | 1.55E+03 | 9.76E+03 |
| MW-32-173 | 7 | 7 | 1.89E+03 | 1.33E+03 | 2.47E+03 |
| MW-32-190 | 8 | 8 | 1.69E+03 | 1.53E+03 | 1.98E+03 |
| MW-32-48 | 4 | 4 | 2.91E+04 | 3.69E+03 | 6.18E+04 |
| MW-32-59 | 8 | 8 | 7.02E+04 | 5.78E+03 | 1.55E+05 |
| MW-32-85 | 8 | 8 | 1.20E+04 | 8.03E+03 | 1.49E+04 |
| MW-33 | 4 | 4 | 2.57E+04 | 3.69E+03 | 6.31E+04 |
| MW-35 | 1 | 1 | 2.82E+03 | 2.82E+03 | 2.82E+03 |
| MW-36-24 | 4 | 4 | 1.77E+03 | 2.64E+02 | 3.53E+03 |
| MW-36-41 | 4 | 4 | 1.26E+04 | 9.56E+03 | 1.56E+04 |
| MW-36-52 | 4 | 4 | 7.15E+03 | 5.97E+03 | 8.49E+03 |
| MW-37-22 | 4 | 4 | 5.69E+03 | 3.70E+03 | 9.06E+03 |
| MW-37-32 | 4 | 4 | 5.93E+03 | 4.80E+03 | 7.24E+03 |
| MW-37-40 | 4 | 4 | 5.87E+03 | 4.70E+03 | 7.00E+03 |
| MW-37-57 | 4 | 4 | 6.07E+03 | 5.07E+03 | 7.30E+03 |
| MW-39-102 | 3 | 3 | 3.31E+02 | 2.39E+02 | 3.93E+02 |
| MW-39-124 | 3 | 2 | 3.41E+02 | 3.08E+02 | 3.73E+02 |
| MW-39-195 | 3 | 1 | 2.16E+02 | 2.16E+02 | 2.16E+02 |
| MW-39-67 | 3 | 3 | 3.46E+02 | 2.86E+02 | 3.79E+02 |
| MW-39-84 | 3 | 3 | 2.82E+02 | 2.25E+02 | 3.70E+02 |
| MW-40-100 | 4 | 1 | 1.39E+02 | 1.39E+02 | 1.39E+02 |
| MW-40-27 | 4 | 2 | 2.00E+02 | 1.93E+02 | 2.06E+02 |
| MW-40-46 | 4 | 3 | 1.74E+02 | 1.24E+02 | 2.35E+02 |
| MW-40-81 | 4 | 2 | 2.20E+02 | 1.92E+02 | 2.48E+02 |
| MW-41-40 | 4 | 4 | 1.65E+03 | 4.32E+02 | 2.79E+03 |
| MW-41-63 | 4 | 4 | 4.27E+02 | 2.48E+02 | 5.18E+02 |
| MW-42-49 | 4 | 4 | 1.31E+03 | 9.79E+02 | 1.69E+03 |
| MW-42-78 | 4 | 4 | 4.99E+02 | 3.57E+02 | 6.31E+02 |
| MW-43-28 | 4 | 3 | 2.11E+02 | 1.95E+02 | 2.25E+02 |
| MW-43-62 | 4 | 1 | 2.16E+02 | 2.16E+02 | 2.16E+02 |
| MW-44-102 | 4 | 4 | 4.32E+02 | 2.76E+02 | 5.12E+02 |
| MW-44-66 | 4 | 4 | 3.49E+02 | 1.75E+02 | 4.75E+02 |
| MW-45-42 | 4 | 4 | 3.08E+03 | 2.02E+03 | 3.86E+03 |
| MW-45-61 | 4 | 4 | 1.23E+03 | 9.89E+02 | 1.51E+03 |
| MW-46 | 4 | 4 | 1.74E+03 | 7.62E+02 | 3.13E+03 |

## Tritium Summary



| | | | | | |
|---|---|---|---|---|---|
| MW-49-26 | 4 | 4 | 2.86E+03 | 2.59E+03 | 3.03E+03 |
| MW-49-42 | 4 | 4 | 2.41E+03 | 2.20E+03 | 2.76E+03 |
| MW-49-65 | 4 | 4 | 1.42E+03 | 1.32E+03 | 1.55E+03 |
| MW-50-42 | 4 | 4 | 6.90E+02 | 1.61E+02 | 1.36E+03 |
| MW-50-66 | 4 | 4 | 3.21E+03 | 2.76E+03 | 3.72E+03 |
| MW-51-40 | 4 | 2 | 1.59E+02 | 1.48E+02 | 1.70E+02 |
| MW-51-79 | 4 | 1 | 1.10E+02 | 1.10E+02 | 1.10E+02 |
| MW-52-11 | 1 | 1 | 3.73E+02 | 3.73E+02 | 3.73E+02 |
| MW-52-162 | 1 | 1 | 2.60E+02 | 2.60E+02 | 2.60E+02 |
| MW-52-18 | 1 | 1 | 3.01E+02 | 3.01E+02 | 3.01E+02 |
| MW-52-181 | 1 | 1 | 2.18E+02 | 2.18E+02 | 2.18E+02 |
| MW-53-120 | 4 | 4 | 4.12E+03 | 3.81E+03 | 4.66E+03 |
| MW-53-82 | 4 | 4 | 4.17E+03 | 2.25E+03 | 7.14E+03 |
| MW-54-123 | 4 | 4 | 8.42E+02 | 7.83E+02 | 9.16E+02 |
| MW-54-144 | 4 | 4 | 1.32E+03 | 1.20E+03 | 1.44E+03 |
| MW-54-173 | 4 | 4 | 1.67E+03 | 1.51E+03 | 2.03E+03 |
| MW-54-190 | 4 | 4 | 1.70E+03 | 1.57E+03 | 1.93E+03 |
| MW-54-37 | 4 | 4 | 1.29E+03 | 1.18E+03 | 1.45E+03 |
| MW-54-58 | 4 | 4 | 9.01E+02 | 7.67E+02 | 1.11E+03 |
| MW-55-24 | 4 | 4 | 1.61E+03 | 1.21E+03 | 2.21E+03 |
| MW-55-35 | 4 | 4 | 1.99E+03 | 1.57E+03 | 2.49E+03 |
| MW-55-54 | 4 | 4 | 9.49E+03 | 8.23E+03 | 1.13E+04 |
| MW-56-53 | 2 | 2 | 3.61E+02 | 2.58E+02 | 4.64E+02 |
| MW-56-83 | 2 | 2 | 2.34E+03 | 1.93E+03 | 2.74E+03 |
| MW-57-11 | 1 | 1 | 3.27E+03 | 3.27E+03 | 3.27E+03 |
| MW-57-20 | 1 | 1 | 8.07E+02 | 8.07E+02 | 8.07E+02 |
| MW-57-45 | 1 | 1 | 8.79E+02 | 8.79E+02 | 8.79E+02 |
| MW-58-26 | 2 | 2 | 4.71E+02 | 3.66E+02 | 5.75E+02 |
| MW-58-65 | 2 | 2 | 4.20E+02 | 3.59E+02 | 4.81E+02 |
| MW-60-135 | 4 | 4 | 2.90E+02 | 1.87E+02 | 4.18E+02 |
| MW-60-154 | 4 | 4 | 3.94E+02 | 2.93E+02 | 4.68E+02 |
| MW-60-176 | 4 | 4 | 9.07E+02 | 8.13E+02 | 9.93E+02 |
| MW-60-35 | 4 | 4 | 2.53E+02 | 2.35E+02 | 2.85E+02 |
| MW-60-53 | 4 | 3 | 2.84E+02 | 2.49E+02 | 3.45E+02 |
| MW-60-72 | 4 | 1 | 3.01E+02 | 3.01E+02 | 3.01E+02 |
| MW-62-138 | 4 | 4 | 5.89E+02 | 3.31E+02 | 7.81E+02 |
| MW-62-18 | 4 | 2 | 2.46E+02 | 2.04E+02 | 2.87E+02 |
| MW-62-182 | 4 | 4 | 4.25E+02 | 2.78E+02 | 4.77E+02 |
| MW-62-37 | 4 | 3 | 2.81E+02 | 1.91E+02 | 3.93E+02 |
| MW-62-53 | 4 | 4 | 2.59E+02 | 1.59E+02 | 3.46E+02 |
| MW-62-71 | 4 | 4 | 3.94E+02 | 3.25E+02 | 4.56E+02 |
| MW-62-92 | 4 | 4 | 4.81E+02 | 3.18E+02 | 5.96E+02 |
| MW-63-112 | 4 | 4 | 3.75E+02 | 3.01E+02 | 4.47E+02 |
| MW-63-121 | 4 | 4 | 5.45E+02 | 5.15E+02 | 6.06E+02 |
| MW-63-163 | 4 | 4 | 4.95E+02 | 4.13E+02 | 5.94E+02 |
| MW-63-174 | 4 | 4 | 4.00E+02 | 2.63E+02 | 5.05E+02 |
| MW-63-18 | 4 | 4 | 2.53E+02 | 1.62E+02 | 3.38E+02 |
| MW-63-34 | 4 | 4 | 3.04E+02 | 1.89E+02 | 3.96E+02 |
| MW-63-50 | 4 | 4 | 3.37E+02 | 2.72E+02 | 4.13E+02 |

## Tritium Summary



| | | | | | |
|---|---|---|---|---|---|
| MW-63-93 | 4 | 4 | 2.57E+02 | 1.95E+02 | 3.03E+02 |
| MW-66-21 | 4 | 4 | 1.44E+03 | 3.22E+02 | 3.43E+03 |
| MW-66-36 | 4 | 4 | 2.70E+03 | 9.60E+02 | 3.64E+03 |
| MW-67-105 | 4 | 4 | 1.38E+03 | 1.14E+03 | 1.59E+03 |
| MW-67-173 | 4 | 4 | 7.11E+02 | 6.25E+02 | 8.70E+02 |
| MW-67-219 | 4 | 4 | 1.14E+03 | 1.09E+03 | 1.20E+03 |
| MW-67-276 | 4 | 4 | 1.04E+03 | 9.33E+02 | 1.11E+03 |
| MW-67-323 | 4 | 4 | 4.34E+02 | 3.88E+02 | 4.71E+02 |
| MW-67-340 | 4 | 4 | 5.68E+02 | 4.86E+02 | 6.57E+02 |
| MW-67-39 | 4 | 4 | 3.20E+03 | 2.55E+03 | 3.56E+03 |
| U1-CSS | 2 | 2 | 2.07E+03 | 1.88E+03 | 2.26E+03 |
| U3-4D | 4 | 4 | 8.33E+02 | 6.84E+02 | 1.07E+03 |
| U3-4S | 2 | 2 | 3.63E+02 | 3.51E+02 | 3.74E+02 |
| U3-T1 | 4 | 4 | 4.16E+02 | 3.04E+02 | 5.00E+02 |
| U3-T2 | 4 | 4 | 1.07E+03 | 8.76E+02 | 1.47E+03 |

Note 1: All results are in pCi/L

Note 2: A total of 465 samples were analyzed for H-3 in 2010 with 403 positive results. See the AREOR for additional data.

Note 3: A sample is positive if the result is greater than or equal to 3 times the 1 sigma uncertainty. The target MDC is 200 pCi/L.

## Cobalt-60 Summary

| Well Name | # Samples in 2010 | # Positive Samples in 2010 | Ave Pos Act | Min Pos Act | Max Pos Act |
|---|---|---|---|---|---|
| MW-39-84 | 3 | 1 | 7.47E+00 | 7.47E+00 | 7.47E+00 |
| MW-39-195 | 3 | 1 | 8.70E+00 | 8.70E+00 | 8.70E+00 |

Note 1: All results are in pCi/L
Note 2: A total of 465 samples were analyzed for Co-60 in 2010 with 2 positive results. See the AREOR for additional data.
Note 3: A sample is positive if the result is greater than or equal to 3 times the 1 sigma uncertainty. The target MDC is 15 pCi/L.

## Nickel-63 Summary

| Well Name | # Samples in 2010 | # Positive Samples in 2010 | Ave Pos Act | Min Pos Act | Max Pos Act |
|---|---|---|---|---|---|
| MW-42-49 | 4 | 4 | 3.37E+02 | 1.77E+02 | 7.10E+02 |
| MW-60-53 | 4 | 1 | 1.10E+01 | 1.10E+01 | 1.10E+01 |
| MW-66-21 | 4 | 1 | 9.56E+00 | 9.56E+00 | 9.56E+00 |

Note 1: All results are in pCi/L
Note 2: A total of 135 samples were analyzed for Ni-63 in 2010 with 6 positive results. See the AREOR for additional data.
Note 3: A sample is positive if the result is greater than or equal to 3 times the 1 sigma uncertainty. The target MDC is 30 pCi/L.

## Cesium-137 Summary

| Well Name | # Samples in 2010 | # Positive Samples in 2010 | Ave Pos Act | Min Pos Act | Max Pos Act |
|---|---|---|---|---|---|
| B-1 | 4 | 3 | 1.71E+01 | 9.79E+00 | 2.27E+01 |
| MW-111 | 5 | 1 | 6.79E+00 | 6.79E+00 | 6.79E+00 |
| MW-32-59 | 8 | 1 | 4.95E+00 | 4.95E+00 | 4.95E+00 |
| MW-42-49 | 4 | 4 | 3.29E+04 | 1.87E+04 | 6.52E+04 |
| MW-49-65 | 4 | 1 | 6.99E+00 | 6.99E+00 | 6.99E+00 |
| MW-55-24 | 4 | 1 | 4.99E+00 | 4.99E+00 | 4.99E+00 |
| MW-63-18 | 4 | 1 | 5.09E+00 | 5.09E+00 | 5.09E+00 |
| MW-66-21 | 4 | 1 | 6.04E+00 | 6.04E+00 | 6.04E+00 |
| MW-66-36 | 4 | 1 | 5.42E+00 | 5.42E+00 | 5.42E+00 |

Note 1: All results are in pCi/L
Note 2: A total of 465 samples were analyzed for Cs-137 in 2010 with 14 positive results. See the AREOR for additional data.
Note 3: A sample is positive if the result is greater than or equal to 3 times the 1 sigma uncertainty. The target MDC is 18 pCi/L.

## Strontium-90 Summary



| Well Name | # Samples in 2010 | # Positive Samples in 2010 | Ave Pos Act | Min Pos Act | Max Pos Act |
|---|---|---|---|---|---|
| MW-111 | 5 | 3 | 1.45E+00 | 1.07E+00 | 1.80E+00 |
| MW-30-69 | 8 | 1 | 9.69E-01 | 9.69E-01 | 9.69E-01 |
| MW-36-41 | 4 | 4 | 3.99E+00 | 1.88E+00 | 5.95E+00 |
| MW-36-52 | 4 | 3 | 4.07E+00 | 2.12E+00 | 5.36E+00 |
| MW-37-22 | 4 | 4 | 1.10E+01 | 5.19E+00 | 1.38E+01 |
| MW-37-32 | 4 | 3 | 1.77E+01 | 1.41E+01 | 2.03E+01 |
| MW-37-40 | 4 | 4 | 1.42E+01 | 1.25E+01 | 1.71E+01 |
| MW-37-57 | 4 | 4 | 1.84E+01 | 1.73E+01 | 1.97E+01 |
| MW-39-102 | 3 | 2 | 2.73E+00 | 1.40E+00 | 4.05E+00 |
| MW-39-124 | 3 | 2 | 1.71E+00 | 1.17E+00 | 2.25E+00 |
| MW-39-67 | 3 | 3 | 1.65E+00 | 1.26E+00 | 1.96E+00 |
| MW-39-84 | 3 | 3 | 1.30E+00 | 8.43E-01 | 1.80E+00 |
| MW-41-40 | 4 | 4 | 3.64E+00 | 2.09E+00 | 4.37E+00 |
| MW-41-63 | 4 | 4 | 3.68E+00 | 2.01E+00 | 4.79E+00 |
| MW-42-49 | 4 | 4 | 4.50E+01 | 1.39E+01 | 1.24E+02 |
| MW-45-42 | 4 | 1 | 6.43E-01 | 6.43E-01 | 6.43E-01 |
| MW-46 | 4 | 1 | 8.57E-01 | 8.57E-01 | 8.57E-01 |
| MW-49-26 | 4 | 3 | 1.40E+01 | 1.28E+01 | 1.55E+01 |
| MW-49-42 | 4 | 4 | 1.86E+01 | 1.75E+01 | 1.99E+01 |
| MW-49-65 | 4 | 4 | 1.31E+01 | 1.04E+01 | 1.55E+01 |
| MW-50-42 | 4 | 4 | 5.52E+00 | 3.73E+00 | 8.43E+00 |
| MW-50-66 | 4 | 4 | 2.62E+01 | 2.33E+01 | 2.99E+01 |
| MW-53-120 | 4 | 4 | 3.30E+01 | 2.96E+01 | 3.94E+01 |
| MW-53-82 | 4 | 2 | 1.52E+00 | 8.07E-01 | 2.23E+00 |
| MW-54-123 | 4 | 4 | 4.07E+00 | 2.25E+00 | 7.65E+00 |
| MW-54-144 | 4 | 4 | 1.27E+01 | 1.08E+01 | 1.44E+01 |
| MW-54-173 | 4 | 4 | 6.10E+00 | 4.65E+00 | 7.51E+00 |
| MW-54-190 | 4 | 4 | 2.02E+01 | 1.57E+01 | 2.35E+01 |
| MW-54-37 | 4 | 4 | 4.60E+00 | 4.00E+00 | 5.17E+00 |
| MW-54-58 | 4 | 4 | 1.71E+00 | 1.36E+00 | 2.67E+00 |
| MW-55-24 | 4 | 4 | 1.49E+01 | 8.64E+00 | 2.06E+01 |
| MW-55-35 | 4 | 4 | 2.13E+01 | 1.13E+01 | 3.10E+01 |
| MW-55-54 | 4 | 4 | 1.96E+01 | 1.67E+01 | 2.32E+01 |
| MW-56-53 | 2 | 1 | 1.27E+00 | 1.27E+00 | 1.27E+00 |
| MW-56-83 | 2 | 2 | 1.51E+00 | 1.02E+00 | 1.99E+00 |
| MW-57-11 | 1 | 1 | 2.46E+01 | 2.46E+01 | 2.46E+01 |
| MW-57-20 | 1 | 1 | 1.12E+00 | 1.12E+00 | 1.12E+00 |
| MW-57-45 | 1 | 1 | 1.30E+00 | 1.30E+00 | 1.30E+00 |
| MW-62-138 | 4 | 3 | 1.21E+00 | 8.78E-01 | 1.47E+00 |
| MW-62-18 | 4 | 1 | 6.60E-01 | 6.60E-01 | 6.60E-01 |
| MW-62-182 | 4 | 1 | 1.02E+00 | 1.02E+00 | 1.02E+00 |
| MW-62-37 | 4 | 1 | 7.62E-01 | 7.62E-01 | 7.62E-01 |
| MW-66-21 | 4 | 2 | 4.10E+00 | 1.17E+00 | 7.03E+00 |
| MW-66-36 | 4 | 4 | 5.44E+00 | 8.97E-01 | 7.43E+00 |
| MW-67-105 | 4 | 3 | 1.93E+00 | 1.41E+00 | 2.61E+00 |

## Strontium-90 Summary



| | | | | | |
|---|---|---|---|---|---|
| MW-67-323 | 4 | 1 | 6.38E-01 | 6.38E-01 | 6.38E-01 |
| MW-67-39 | 4 | 4 | 9.03E+00 | 5.43E+00 | 1.24E+01 |
| U1-CSS | 2 | 2 | 1.04E+01 | 8.95E+00 | 1.18E+01 |
| U3-T2 | 4 | 1 | 6.31E-01 | 6.31E-01 | 6.31E-01 |

Note 1: All results are in pCi/L

Note 2: A total of 465 samples were analyzed for Sr-90 in 2010 with 140 positive results. See the AREOR for additional data.

Note 3: A sample is positive if the result is greater than or equal to 3 times the 1 sigma uncertainty. The target MDC is 1 pCi/L.