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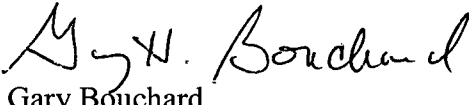
Zion Nuclear Power Station, Units 1 and 2  
Facility Operating License Nos. DPR-39 and DPR-48  
NRC Docket Nos. 50-295 and 50-304

Subject: Submittal of Zion Nuclear Power Station, Unit 1 and 2, 2012 Annual Radiological Environmental Operating Report

In accordance with Technical Specification 5.7.2, "Annual Radiological Environmental Operating Report" Zion Station is submitting the 2012 Annual Radiological Environmental Operating Report for Unit 1 and 2. Technical Specification 5.7.2 requires submittal of an Annual Radiological Environmental Operating Report before May 15 of each year. The attachment to this letter is the Annual Radiological Environmental Operating Report.

If you have any questions about this report, please contact Christopher Keene at (224) 789-4073.

Respectfully,

  
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cc: John Hickman, U.S. NRC Senior Project Manager  
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Attachment:  
2012 Annual Radiological Environmental Operating Report

FSME20  
IE25

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NRC Docket No: 50-295

50-304

# **ZION NUCLEAR POWER STATION UNITS 1 and 2**

Annual Radiological  
Environmental Operating Report

1 January Through 31 December 2012

**Prepared By**

Teledyne Brown Engineering  
Environmental Services



Zion Nuclear Power Station  
Zion, IL 60099

**May 2013**

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## I. Summary and Conclusions

This report on the Radiological Environmental Monitoring Program conducted for the Zion Nuclear Power Station (ZNPS) by ZionSolutions (ZS) covers the period 1 January 2012 through 31 December 2012. During that time period, 437 analyses were performed on 361 samples. In assessing all the data gathered for this report and comparing these results with preoperational data, it was concluded that the operation of ZNPS had no adverse radiological impact on the environment.

Public water samples were analyzed for concentrations of gross beta, tritium and gamma emitting nuclides. No fission or activation products were detected. Gross beta activities detected were consistent with those detected in previous years.

Fish (commercially and recreationally important species) and sediment samples were analyzed for concentrations of gamma emitting nuclides. No Cs-137 activity was detected in fish or sediment samples. No plant produced fission or activation products were found in fish or sediment.

Air particulate samples were analyzed for concentrations of gross beta and gamma emitting nuclides. No fission or activation products were detected.

Environmental gamma radiation measurements were performed quarterly using thermoluminescent dosimeters.



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## II. Introduction

The Zion Nuclear Power Station (ZNPS), consisting of two 1,100 MWt pressurized water reactor was owned and operated by Exelon Corporation, is located in Zion, Illinois adjacent to Lake Michigan. Unit No. 1 went critical in December 1973. Unit No. 2 went critical in September 1974. The plant permanently ceased operation in January of 1998 and has been permanently defueled. The site is located in northeast Illinois on the western shore of Lake Michigan, approximately 50 miles north of Chicago, Illinois.

This report covers those analyses performed by Teledyne Brown Engineering (TBE), Mirion and Environmental Inc. (Midwest Labs) on samples collected during the period 1 January 2012 through 31 December 2012.

### A. Objective of the REMP

The objectives of the REMP are to:

1. Provide data on measurable levels of radiation and radioactive materials in the site environs.
2. Evaluate the relationship between quantities of radioactive material released from the plant and resultant radiation doses to individuals from principal pathways of exposure.

### B. Implementation of the Objectives

The implementation of the objectives is accomplished by:

1. Identifying significant exposure pathways.
2. Establishing baseline radiological data of media within those pathways.
3. Continuously monitoring those media before and during Station operation to assess Station radiological effects (if any) on man and the environment.

## III. Program Description

### A. Sample Collection

Samples for the ZNPS REMP were collected for ZS by Environmental Inc. (Midwest Labs). This section describes the general collection methods used by Environmental Inc. (Midwest Labs) to obtain environmental

samples for the ZNPS REMP in 2012. Sample locations and descriptions can be found in Table B-1 and Figures B-1 and B-2, Appendix B. The sampling methods used by Environmental Inc. (Midwest Labs) are listed in Table B-2.

#### Aquatic Environment

The aquatic environment was evaluated by performing radiological analyses on samples of public water, fish and sediment. Two gallon water samples were collected monthly from four public water locations (Z-14, Z-15, Z-16 and Z-18). Control locations were Z-14 and Z-18. All samples were collected in new unused plastic bottles, which were rinsed at least twice with source water prior to collection. Fish samples comprising the flesh of common carp, chinook salmon, lake trout, burbot and smallmouth bass were collected semiannually at two locations, Z-26 and Z-27. Sediment samples composed of recently deposited substrate were collected at one location semiannually, Z-25.

#### Atmospheric Environment

The atmospheric environment was evaluated by performing radiological analyses on samples of air particulates. Airborne particulate samples were collected and analyzed weekly at three locations (Z-01, Z-02 and Z-03). No control location was required. Airborne particulate samples were obtained at each location, using a vacuum pump with glass fiber filters attached. The pumps were run continuously and sampled air at the rate of approximately one cubic foot per minute. The filters were replaced weekly and sent to the laboratory for analysis.

#### Ambient Gamma Radiation

Direct radiation measurements were made using 2 CaF 200 and 2 LiF 100 LiF 4-chip Harshaw thermoluminescent dosimeters (TLD). Each location consisted of 2 TLD sets. The TLD locations were placed on and around the ZNPS site at the following locations:

Z-101, Z-102, Z-103, Z-104, Z-105, Z-106, Z-107, Z-108, Z-110, Z-111, Z-112, Z-113, Z-114, Z-115, Z-301, Z-01, Z-02 and Z-03.

No control location was required.

The specific TLD locations were determined by the following criteria:

1. The presence of relatively dense population;

2. Site meteorological data taking into account distance and elevation for each of the sixteen–22 1/2 degree sectors around the site, where estimated annual dose from ZNPS, if any, would be most significant;
3. On hills free from local obstructions and within sight of the vents (where practical);
4. And near the closest dwelling to the vents in the prevailing downwind direction.

(Two TLDs – each comprised of two  $\text{CaF}_2$  200 and 2 LiF 100 LiF 4-chip thermoluminescent phosphors enclosed in plastic – were placed at each location approximately four to eight feet above ground level. The TLDs were exchanged quarterly and sent to Mirion Technologies for analysis.

#### B. Sample Analysis

This section describes the general analytical methodologies used by TBE and Environmental Inc. (Midwest Labs) to analyze the environmental samples for radioactivity for the ZNPS REMP in 2012. The analytical procedures used by the laboratories are listed in Table B-2.

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

1. Concentrations of beta emitters in public water and air particulates.
2. Concentrations of gamma emitters in public water, air particulates, fish and sediment.
3. Concentrations of tritium in public water.
4. Ambient gamma radiation levels at various site environs.

#### C. Data Interpretation

The radiological and direct radiation data collected prior to Zion Nuclear Power Station becoming operational were used as a baseline with which these operational data were compared. For the purpose of this report, Zion Nuclear Power Station was considered operational at initial criticality. In addition, data was compared to previous years' operational data for consistency and trending. 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 defined as the smallest concentration of radioactive material in a sample that would yield a net count (above background) that would be detected with only a 5% probability of falsely concluding that a blank observation represents a "real" signal. The LLD is intended as a before the fact estimate of a system (including instrumentation, procedure and sample type) and not as an after the fact criteria for the presence of activity. All analyses were designed to achieve the required ZNPS detection capabilities for environmental sample analysis.

The minimum detectable concentration (MDC) is defined above with the exception that the measurement is an after the fact estimate of the presence of activity.

2. Net Activity Calculation and Reporting of Results

Net activity for a sample was calculated by subtracting background activity from the sample activity. Since the REMP measures extremely small changes in radioactivity in the environment, background variations may result in sample activity being lower than the background activity affecting a negative number. An MDC was reported in all cases where positive activity was not detected.

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

For public water, sediment and air particulates 11 nuclides, 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.

Means and standard deviations of the results were calculated. The standard deviations represent the variability of measured results for different samples rather than single analysis uncertainty.

D. Program Exceptions

For 2012 the ZNPS REMP had a sample recovery rate in excess of 99%. Sample anomalies and missed samples are listed in the tables below:

Table D-1 LISTING OF SAMPLE ANOMALIES

Sample Type	Location Code	Collection Date	Reason
AP	Z-01	03/07/12	Field check log missing from air sampler; Program Coordinator prepared replacement on 03/07/12.
AP	Z-02	04/25/12	No apparent reason for low reading of 132.8 hours; pump and timer functioning at time of collection; station notified.
AP	Z-03	11/28/12	No apparent reason for low reading of 155.9 hours; pump and timer functioning at time of collection; station notified.
AP	Z-01	12/12/12	Filter torn; fiber backing disk missing from sample holder allowed vacuum to tear filter; collector obtained new holder from EIML.

Due to an incorrect setting on one of twelve gamma detectors, there was an incorrect MDC reported for samples analyzed on this detector.

Teledyne Brown Engineering initiated Nonconformance 13-07 to investigate the issue and corrective actions have been implemented. All samples counted on the affected detector were reprocessed using the correct calculation. As a result, all MDCs for these samples have increased by 41.6%. The previously reported activities and uncertainties were not affected. In some cases, the increased MDC resulted in missed LLDs. All samples with MDCs affected by this issue are listed below. The samples with missed Zr-95 LLDs are shown in the table. All other required LLDs were met.

CLIENT ID	START DATE	END DATE	MATRIX	Zr-95	
				REQUIRED MDC pCi/L	REVISED MDC pCi/L
Z-16	03/07/12	03/28/12	Public water		
Z-02	03/28/12	06/27/12	Air particulate		
Z-16	06/06/12	06/27/12	Public water	<15	<15.4
Z-14	07/05/12	07/25/12	Public water	<15	<18.6
Z-16	09/05/12	09/26/12	Public water	<15	<15.9
Z-01	09/26/12	01/02/13	Air particulate		
Z-02	09/26/12	01/02/13	Air particulate		
Z-14	12/05/12	12/26/12	Public water		
Z-15	12/05/12	12/26/12	Public water		
Z-18	12/05/12	12/26/12	Public water	<15	<15.1
Z-16	12/15/12	12/26/12	Public water	<15	<16.6
MW-ZN-06S		06/08/12	Groundwater		
MW-ZN-061		09/18/12	Groundwater		
MW-ZN-068		09/20/12	Groundwater		
MW-ZN-07S		10/02/12	Groundwater		

Table D-2 LISTING OF MISSED SAMPLES

Sample Type	Location Code	Collection Date	Reason
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There were no missed samples for 2012.

Each program exception was reviewed to understand the causes of the program exception. Sampling and maintenance errors were reviewed with the personnel involved to prevent recurrence. Occasional equipment breakdowns and power outages were unavoidable.

The overall sample recovery rate indicates that the appropriate procedures and equipment are in place to assure reliable program implementation.

E. Program Changes

There were no changes to the REMP program in 2012.

#### IV. Results and Discussion

##### A. Aquatic Environment

###### 1. Public Water

Samples were taken weekly and composited monthly at four locations (Z-14, Z-15, Z-16 and Z-18). The following analyses were performed.

###### Gross Beta

Samples from all locations were analyzed for concentrations of gross beta (Table C-I.1, Appendix C). Gross beta was detected in 36 of 48 samples. The values ranged from 1.7 pCi/l to 4.5 pCi/l. Concentrations detected were consistent with those detected in previous years (Figures C-1 and C-2, Appendix C).

###### Tritium

Quarterly composites of weekly collections were analyzed for tritium activity (Table C-I.2, Appendix C). No tritium was detected and the LLD was met (Figures C-3 and C-4, Appendix C).

###### Gamma Spectrometry

Samples from both locations were analyzed for gamma emitting nuclides (Table C-I.3, Appendix C). No nuclides were detected and all required LLDs were met.

###### 2. Fish

Fish samples comprised of common carp, chinook salmon, lake trout, burbot and smallmouth bass were collected at two locations (Z-26 and Z-27) semiannually. The following analysis was performed:

###### Gamma Spectrometry

The edible portion of fish samples from both locations was analyzed for gamma emitting nuclides (Table C-II.1, Appendix C). No nuclides were detected and all required LLDs were met.



### 3. Sediment

Aquatic sediment samples were collected at one location (Z-25) semiannually. The following analysis was performed:

#### Gamma Spectrometry

Sediment samples from Z-25 were analyzed for gamma emitting nuclides (Table C–III.1, Appendix C). No nuclides were detected and all required LLDs were met.

### B. Atmospheric Environment

#### 1. Airborne

##### a. Air Particulates

Continuous air particulate samples were collected from three locations on a weekly basis. The three locations were within the ZNPS site boundary (Z-01, Z-02 and Z-03). The following analyses were performed:

#### Gross Beta

Weekly samples were analyzed for concentrations of beta emitters (Table C–IV.1 and C–IV.2, Appendix C). Detectable gross beta activity was observed at all locations. Comparison of results among the three groups aid in determining the effects, if any, resulting from the operation of ZNPS. The results from the On-Site locations ranged from  $6 \text{ E-3 pCi/m}^3$  to  $42 \text{ E-3 pCi/m}^3$  with a mean of  $18 \text{ E-3 pCi/m}^3$ . Comparison of the 2012 air particulate data with previous years data indicate no effects from the operation of ZNPS. Concentrations detected were consistent with those detected in previous years.

#### Gamma Spectrometry

Weekly samples were composited quarterly and analyzed for gamma emitting nuclides (Table C–IV.3, Appendix C). No nuclides were detected and all required LLDs were met.

### C. Ambient Gamma Radiation

Ambient gamma radiation levels were measured utilizing Harshaw (CaF

and LiF) thermoluminescent dosimeters. Thirty-six TLD locations were established around the site. Results of TLD measurements are listed in Tables C–V.1 to C–V.3, Appendix C.

Most TLD measurements were below 25 mR/quarter, with a range of 16 mR/quarter to 45 mR/quarter.

D. Land Use Survey

A Land Use Census conducted during August 2012 around the Zion Nuclear Power Station (ZNPS) was performed by Environmental Inc. (Midwest Labs) for ZS to comply with Chapter 3 of the Zion Offsite Dose Calculation Manual. The purpose of the survey was to document the nearest resident, milk producing animal and garden of greater than 500 ft<sup>2</sup> in each of the sixteen 22 ½ degree sectors around the site. It was identified in 2012 while reviewing the results of the land use census that only the nearest resident was being reviewed and no formal review for milk producing animal or garden of greater than 500 ft<sup>2</sup> was being performed nor had they been performed since the year 2000. Exelon performed a justification for not performing these reviews in 2000. This does not meet the intent of NUREG-1301 or Chapter 3 of the ODCM. Zion Condition Report CR-2012-001362 was initiated to document this finding. The Annual Land Use Census needs to be performed during the growing season and Zion was unable to perform these reviews in 2012. A corrective action, CR-2012-001362-CA001, is tracking completion of the Land Use Census for 2013 to ensure compliance with the ODCM and meet the intent of NUREG-1301. The scope of work for Environmental Inc. (Midwest Labs) was also changed to include the requirement to perform the review of milk producing animal and garden of greater than 500 ft<sup>2</sup> for 2013 and future years in each of the sixteen 22 ½ degree sectors around the site. The results of this survey are summarized below.

Sector	Residence Miles
A N	2.5
B NNE	-
C NE	-
D ENE	-
E E	-
F ESE	-
G SE	-
H SSE	-
J S	-
K SSW	1.9
L SW	1.1
M WSW	1.0
N W	1.1
P WNW	1.0
Q NW	1.0
R NNW	1.3

#### E. Errata Data

##### Errata Data for Unmonitored Release/Release Potential 2010 - 2011

CR-2013-000165 Identified a potential unmonitored release path upstream of both Unit 1 and Unit 2 vent stack radiation monitors via backflow into the Off-Gas system piping into the turbine building. There were two identified paths in Unit 2 and one in Unit 1. During additional walk downs there was an additional path in Unit 1. Applicable valves were shut and a clearance order was generated which danger tagged shut the valves in Unit 2(see CO108065). The two paths in Unit 1 had no associated valves, as a result, the lines were cut and capped removing them as a release path. (See WO 01614942). Plant modifications were reviewed and it was determined that this condition existed prior to Zion Solutions licensing at Zion Station. The purpose of this erratum is to report the additional dose to a member of the public that was not included in the prior years of 2010 and 2011 due to this unmonitored path. All years prior to 2010 will be evaluated at a later date and any errata data identified will be included in the 2013 reports.

Engineering determined the calculated the maximum flow through this potential release path to be 1.90E+02 cfm at the maximum designed vent flow of 1.50E+05 cfm. A Bounding ratio of 1.27E-03 of the ventilation flow was diverted to this unmonitored path and will be used in calculations for correcting dose impact to the public. This bounding flow rate is conservative as no flow was detected from these paths at a vent flow of approximately 8.00E+04 cfm through physical observation.

Method used to calculate new values:

1. Took values reported for 2011: Only Qtr. 4 in Unit 1 had uncalculated dose contribution from Cs-137 and Co-60.
  - a. Qtr. 4 Any organ infant liver  $6.32\text{e-}04$  mrem
  - b. Qtr. 4 Total Body Adult TBody  $2.26\text{e-}04$  mrem
2. Determined total percent contribution of previously unaccounted for nuclides: Sum the percentage of nuclide contributions. (GMILK) is Goat Milk (GPD) is Ground Plane Deposition.
  - a. Pathway (GMILK) Cs-137 + Co-60 =  $1.71\text{e+}01\%$  +  $7.92\text{e+}01\%$  =  $9.63\text{e+}01\%$
  - b. Pathway (GPD) Co-60 + Cs-137 =  $4.86\text{e+}01\%$  +  $4.33\text{e+}01\%$  =  $9.19\text{e+}01\%$
3. Determined dose contribution for unaccounted for nuclides per each pathway: Multiply Previously reported dose by total percent contribution of unaccounted for nuclides.
  - a. Pathway (GMILK)  $6.32\text{e-}04$  mrem X  $9.63\text{e-}01$  =  $6.09\text{e-}04$  mrem
  - b. Pathway (GPD)  $2.26\text{e-}04$  mrem X  $9.19\text{e-}01$  =  $2.077\text{e-}04$  mrem
4. Determined unaccounted for dose contribution: Multiply pathway dose contribution by bounding ratio of  $1.27\text{e-}03$ .
  - a. Pathway (GMILK)  $6.09\text{e-}04$  mrem X  $1.27\text{e-}03$  =  $7.73\text{e-}07$  mrem
  - b. Pathway (GPD)  $2.077\text{e-}04$  mrem X  $1.27\text{e-}03$  =  $2.64\text{e-}07$  mrem
5. Determined new total dose for the Quarter: Sum unaccounted for dose contribution to value previously reported.
  - a. Qtr. 4 Any Organ Infant Liver  $6.32\text{e-}04$  mrem +  $7.73\text{e-}04$  mrem =  $6.33\text{e-}04$  mrem
  - b. Qtr. 4 Total Body Adult TBody  $2.26\text{e-}04$  mrem +  $2.64\text{e-}07$  mrem =  $2.26\text{e-}04$  mrem
6. Created chart showing new maximum % of Administrative and Technical Specification Limits and show % delta from previous year.

## Unit 1

2010: Ventilation secured, there was no change in release.

2011: Quarter 1-3 All releases accounted for.

2011: Quarter 4:

Pathway: Grs/Goat/Milk (GMILK)							
Qtr.	Limit		Organ	previously reported dose (mrem)	dose add. (mrem)	new Qtr. dose (mrem)	Limit (mrem)
4	Admin	Any Organ	infant liver	6.32E-04	7.73E-07	6.33E-04	5.63E+00
4	T. Spc.	Any Organ	infant liver	6.32E-04	7.73E-07	6.33E-04	7.50E+00

Pathway: Ground Plane Deposition (GPD)							
Qtr.	Limit	Age Group	Organ	previously reported dose (mrem)	dose add. (mrem)	new Qtr. dose (mrem)	Limit (mrem)
4	Admin.	Total Body	Adult Tbody	2.26E-04	2.64E-07	2.26E-04	5.25E+00
4	T. Spc.	Total Body	Adult Tbody	2.26E-04	2.64E-07	2.26E-04	7.50E+00

## Unit 2

2010: All releases accounted for.

2011: All releases accounted for.

Due to an incorrect setting on one of twelve gamma detectors, there was an incorrect MDC reported for samples analyzed on this detector. Teledyne Brown Engineering initiated Nonconformance 13-07 to investigate the issue and corrective actions have been implemented. As a result, all MDCs for these samples have increased by 41.6%. The previously reported activities and uncertainties were not affected. One public water sample at Location Z-18, collection date 12/01/11 through 12/28/11 was reprocessed using the correct calculation. All required LLDs were met.

Public Water Location Z-18 (collected 12/01/11 – 12/28/11)			
Nuclide	MDC, original result	MDC, reprocessed result	Required LLD
Mn-54	<5	<7	<15
Co-58	<6	<9	<15
Fe-59	<14	<20	<30
Co-60	<4	<6	<15
Zn-65	<8	<12	<30
Nb-95	<7	<10	<15
Zr-95	<10	<15	<15
Cs-134	<4	<6	<15
Cs-137	<5	<7	<18
Ba-140	<63	<89	NA
La-140	<22	<31	NA

F. Summary of Results – Inter-Laboratory Comparison Program

The primary and secondary laboratories analyzed Performance Evaluation (PE) samples of air particulate, air iodine, milk, soil, vegetation and water matrices for (Appendix D). The PE samples, supplied by Analytics Inc., Environmental Resource Associates (ERA) and DOE's Mixed Analyte Performance Evaluation Program (MAPEP), were evaluated against the following pre-set acceptance criteria:

1. Analytics Evaluation Criteria

Analytics' evaluation report provides a ratio of laboratory results and Analytics' known value. Since flag values are not assigned by Analytics, TBE-ES evaluates the reported ratios based on internal QC requirements, which are based on the DOE MAPEP criteria.

2. ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the USEPA, National Environmental Laboratory Accreditation Conference (NELAC), state specific performance testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

### 3. DOE Evaluation Criteria

MAPEP's evaluation report provides an acceptance range with associated flag values.

The MAPEP defines three levels of performance: Acceptable (flag = "A"), Acceptable with Warning (flag = "W"), and Not Acceptable (flag = "N"). Performance is considered acceptable when a mean result for the specified analyte is  $\pm 20\%$  of the reference value. Performance is acceptable with warning when a mean result falls in the range from  $\pm 20\%$  to  $\pm 30\%$  of the reference value (i.e.,  $20\% < \text{bias} < 30\%$ ). If the bias is greater than 30%, the results are deemed not acceptable.

For the TBE laboratory, 12 out of 18 analytes met the specified acceptance criteria. Six analytes (Co-60, Gross Alpha, Gross Beta, Sr-89,

Sr-90 and Zn-65) did not meet the specified acceptance criteria for the following reason:

1. Teledyne Brown Engineering's MAPEP March 2012 Co-60 in soil result of 7.61 Bq/kg was higher than the known value of 1.56 Bq/kg, resulting in a found to known ratio of 4.88 on a sensitivity evaluation. NCR 12-08 was initiated to investigate this failure. No cause could be found for the failure. TBE is monitoring the Co-60 in soil analyses on a case-to-case basis. Sensitivity evaluations are primarily a qualitative assessment. Since Cobalt-60 was not observed in any Radiological Environmental Monitoring Program (REMP) samples, there was no impact to client samples as a result of this issue.
2. Teledyne Brown Engineering's MAPEP March 2012 Zn-65 in AP result of 4.19 Bq/sample was higher than the known value of 2.99 Bq/sample, exceeding the upper control limit of 3.89 Bq/sample. NCR 12-08 was initiated to investigate this failure. No cause could be found for the failure and is considered an anomaly specific to the MAPEP sample. The first and second quarter 2012 Analytics AP Zn-65 analyses were acceptable. Since Zn-65 was not present in any REMF samples, there was no impact to client samples as a result of this issue.
3. Teledyne Brown Engineering's MAPEP September 2012 Sr-90 in water result of 19.6 pCi/L was higher than the known value of 12.2 pCi/L, exceeding the upper control limit of 15.9 pCi/L. NCR 12-11 was initiated to investigate this failure. An incorrect aliquot was

entered into LIMS. Using the correct aliquot, the result would have fallen within the acceptance range. The failure was specific to the sample, therefore there was no impact to client samples as a result of this issue.

4. Teledyne Brown Engineering's ERA May 2012 Gross Alpha in water result of 82.4 pCi/L was higher than the known value of 62.9 pCi/L, which exceeded the upper control limit of 78.0 pCi/L. NCR 12-05 was initiated to investigate this failure. The G-1 detector is slightly biased high for Th-230 based measurements. The G-1 detector is used only for ERA samples. The detector was recalibrated. The failure was specific to the ERA sample, therefore there was no impact to client samples as a result of this issue.
5. Teledyne Brown Engineering's ERA November 2012 Gross Beta in water result of 59.3 pCi/L was higher than the known value of 39.2 pCi/L, which exceeded the upper control limit of 46.7 pCi/L. NCR 12-13 was initiated to investigate this failure. The rerun result of 44.8 fell within the control limits. It appears an incorrect aliquot was entered into LIMS. The failure was specific to the ERA sample, therefore there was no impact to client samples as a result of this issue.
6. Teledyne Brown Engineering's ERA November 2012 Sr-89 in water result of 46.5 pCi/L was higher than the known value of 39.1 pCi/L, which exceeded the upper control limit of 46.1 pCi/L. NCR 12-13 was initiated to investigate this failure. The found to known ratio was 1.19, which TBE considers acceptable with warning, therefore there was no impact to client samples as a result of this issue.

For the EIML laboratory, 12 out of 14 analytes met the specified acceptance criteria. Two analytes (Gross Beta and Co-57) did not meet the specified acceptance criteria for the following reason:

1. Environmental Inc., Midwest Laboratory's ERA April 2012 Gross Beta in water result of 76.2 pCi/L was higher than the known value of 44.2 pCi/L, exceeding the upper control limit of 51.5 pCi/L. The rerun result of 38.3 fell within the control limits. A sample dilution problem is suspected. The failure was specific to the ERA sample, therefore there was no impact to client samples as a result of this issue.
2. Environmental Inc., Midwest Laboratory's MAPEP August 2012 Co-57 in vegetation result of 7.44 pCi/L was higher than the known value of 5.66 pCi/L, exceeding the upper control limit of 7.36 pCi/L.



The recount result of 6.74 fell within the control limits. The sample was recounted using a geometry more closely matched to the MAPEP sample size. The failure was specific to the MAPEP sample, therefore there was no impact to client samples as a result of this issue.

The Inter-Laboratory Comparison Program provides evidence of “in control” counting systems and methods, and that the laboratories are producing accurate and reliable data.

## **APPENDIX A**

### **RADIOLOGICAL ENVIRONMENTAL MONITORING REPORT SUMMARY**

**TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR  
THE ZION NUCLEAR POWER STATION, 2012**

Name of Facility: ZION Location of Facility: ZION IL				DOCKET NUMBER: 50-295 & 50-304 2012 REPORTING PERIOD: ANNUAL				
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS	CONTROL LOCATION	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
				MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
PUBLIC WATER (PCI/LITER)	GR-B	48	4	2.5 (26/36) (1.8/4.5)	2.5 (10/12) (1.7/3.6)	2.7 (9/12) (2.0/4.5)	Z-14 INDICATOR KENOSHA WATER WORKS 10.0 MILES N OF SITE	0
	H-3	16	200	<LLD	<LLD	-		0
	GAMMA MN-54	48	15	<LLD	<LLD	-		0
	CO-58		15	<LLD	<LLD	-		0
	FE-59		30	<LLD	<LLD	-		0
	CO-60		15	<LLD	<LLD	-		0
	ZN-65		30	<LLD	<LLD	-		0

\* THE MEAN AND 2 STANDARD DEVIATION VALUES ARE CALCULATED USING THE POSITIVE VALUES  
FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

**TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR  
THE ZION NUCLEAR POWER STATION, 2012**

Name of Facility: ZION Location of Facility: ZION IL				DOCKET NUMBER: 50-295 & 50-304 2012 REPORTING PERIOD: ANNUAL		LOCATION WITH HIGHEST ANNUAL MEAN (M)		
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (M) (F) RANGE	CONTROL LOCATION MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
PUBLIC WATER (PCI/LITER)	NB-95		15	<LLD	<LLD	-		0
	ZR-95		15	<LLD	<LLD	-		0
	CS-134		15	<LLD	<LLD	-		0
	CS-137		18	<LLD	<LLD	-		0
	BA-140		NA	<LLD	<LLD	-		0
	LA-140		NA	<LLD	<LLD	-		0
FISH (PCI/KG WET)	GAMMA MN-54	8	130	<LLD	NA	-		0

\* THE MEAN AND 2 STANDARD DEVIATION VALUES ARE CALCULATED USING THE POSITIVE VALUES  
FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR LOCATIONS MEAN (M) (F) RANGE	CONTROL LOCATION MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
FISH (PCI/KG WET)	CO-58		130	<LLD	NA	-		0
	FE-59		260	<LLD	NA	-		0
	CO-60		130	<LLD	NA	-		0
	ZN-65		260	<LLD	NA	-		0
	NB-95		NA	<LLD	NA	-		0
	ZR-95		NA	<LLD	NA	-		0
	CS-134		100	<LLD	NA	-		0
	CS-137		100	<LLD	NA	-		0

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Name of Facility: ZION Location of Facility: ZION IL				DOCKET NUMBER: 50-295 & 50-304 2012 REPORTING PERIOD: ANNUAL				
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR	CONTROL	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
				LOCATIONS MEAN (M) (F) RANGE	LOCATION MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
FISH (PCI/KG WET)	BA-140		NA	<LLD	NA	-		0
	LA-140		NA	<LLD	NA	-		0
SEDIMENT (PCI/KG DRY)	GAMMA MN-54	2	NA	<LLD	NA	-		0
	CO-58		NA	<LLD	NA	-		0
	FE-59		NA	<LLD	NA	-		0
	CO-60		NA	<LLD	NA	-		0
	ZN-65		NA	<LLD	NA	-		0

\* THE MEAN AND 2 STANDARD DEVIATION VALUES ARE CALCULATED USING THE POSITIVE VALUES  
FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR	CONTROL	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
				MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
SEDIMENT (PCI/KG DRY)	NB-95		NA	<LLD	NA	-		0
	ZR-95		NA	<LLD	NA	-		0
	CS-134		150	<LLD	NA	-		0
	CS-137		180	<LLD	NA	-		0
	BA-140		NA	<LLD	NA	-		0
	LA-140		NA	<LLD	NA	-		0
AIR PARTICULATE (E-3 PCI/CU.METER)	GR-B	159	10	18 (157/159) (6/42)	NA	19 (52/53) (7/42)	Z-01 INDICATOR ONSITE 1 0.3 MILES S OF SITE	0

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FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

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MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR	CONTROL	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
				LOCATIONS MEAN (M) (F) RANGE	LOCATION MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
AIR PARTICULATE (E-3 PCI/CU.METER)	GAMMA MN-54	12	NA	<LLD	NA	-		0
	CO-58		NA	<LLD	NA	-		0
	FE-59		NA	<LLD	NA	-		0
	CO-60		NA	<LLD	NA	-		0
	ZN-65		NA	<LLD	NA	-		0
	NB-95		NA	<LLD	NA	-		0
	ZR-95		NA	<LLD	NA	-		0

\* THE MEAN AND 2 STANDARD DEVIATION VALUES ARE CALCULATED USING THE POSITIVE VALUES  
FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)



**TABLE A-1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ANNUAL SUMMARY FOR  
THE ZION NUCLEAR POWER STATION, 2012**

Name of Facility: ZION Location of Facility: ZION IL				DOCKET NUMBER: 50-295 & 50-304 2012 REPORTING PERIOD: ANNUAL				
MEDIUM OR PATHWAY SAMPLED (UNIT OF MEASUREMENT)	TYPES OF ANALYSIS PERFORMED	NUMBER OF ANALYSIS PERFORMED	REQUIRED LOWER LIMIT OF DETECTION (LLD)	INDICATOR	CONTROL	LOCATION WITH HIGHEST ANNUAL MEAN (M)		
				LOCATIONS MEAN (M) (F) RANGE	LOCATION MEAN (M) (F) RANGE	MEAN (M) (F) RANGE	STATION # NAME DISTANCE AND DIRECTION	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
AIR PARTICULATE (E-3 PCI/CU.METER)	CS-134		10	<LLD	NA	-		0
	CS-137		10	<LLD	NA	-		0
	BA-140		NA	<LLD	NA	-		0
	LA-140		NA	<LLD	NA	-		0
DIRECT RADIATION (MILLI-ROENTGEN/QTR.)	TLD-QUARTERLY	144	NA	20.6 (144/144) (16/45)	NA	27 (4/4) (18/44)	Z-108-1 INDICATOR 0.1 MILES SSE	0

\* THE MEAN AND 2 STANDARD DEVIATION VALUES ARE CALCULATED USING THE POSITIVE VALUES  
FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F)

## **APPENDIX B**

### **LOCATION DESIGNATION, DISTANCE & DIRECTION, AND SAMPLE COLLECTION & ANALYTICAL METHODS**

TABLE B-1: Radiological Environmental Monitoring Program - Sampling Locations, Distance and Direction, Zion Nuclear Power Station, 2012

Location	Location Description	Distance & Direction From Site
<u>A. Public Water</u>		
Z-14	Kenosha Water Works (control)	10.0 miles N
Z-15	Lake County Water Works (indicator)	1.4 miles NNW
Z-16	Waukegan Water Works (indicator)	6.1 miles S
Z-18	Lake Forest Water Works (control)	12.9 miles S
<u>B. Air Particulates</u>		
Z-01	Onsite 1 (indicator)	0.3 miles S
Z-02	Onsite 2 (indicator)	0.2 miles W
Z-03	Onsite 3 (indicator)	0.2 miles NNW
<u>C. Fish</u>		
Z-26	Lake Michigan Nearsite (indicator)	At station
Z-27	Lake Michigan Farsite (indicator)	10.1 miles N
<u>D. Sediment</u>		
Z-25	Lake Michigan, Illinois Beach State Park (indicator)	0.2 miles S
<u>E. Environmental Dosimetry - TLD</u>		
<u>Inner Ring</u>		
Z-101-1 and -2		0.2 miles N
Z-102-1 and -2		0.2 miles NNE
Z-103-1 and -2		0.2 miles NE
Z-104-1 and -2		0.1 miles ENE
Z-105-1 and -2		0.1 miles E
Z-106-1 and -2		0.1 miles ESE
Z-107-1 and -2		0.1 miles SE
Z-108-1 and -2		0.1 miles SSE
Z-110-1 and -2		0.2 miles SSW
Z-111-1 and -2		0.3 miles SW
Z-112-1 and -2		0.7 miles WSW
Z-113-1 and -2		0.6 miles W
Z-114-1 and -2		0.6 miles WNW
Z-115-1 and -2		0.4 miles NW
Z-301-1 and -2		0.5 miles NW
<u>Other</u>		
Z-01-1 and -2	Onsite 1 (indicator)	0.3 miles S
Z-02-1 and -2	Onsite 2 (indicator)	0.2 miles W
Z-03-1 and -2	Onsite 3 (indicator)	0.2 miles NNW

TABLE B-2: Radiological Environmental Monitoring Program – Summary of Sample Collection and Analytical Methods, Zion Nuclear Power Station, 2012

Sample Medium	Analysis	Sampling Method	Analytical Procedure Number
Public Water	Gamma Spectroscopy	Monthly composite from weekly grab samples.	TBE, TBE-2007 Gamma emitting radioisotope analysis  Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Public Water	Gross Beta	Monthly composite from weekly grab samples.	TBE, TBE-2008 Gross Alpha and/or gross beta activity in various matrices  Env. Inc., W(DS)-01 Determination of gross alpha and/or gross beta in water (dissolved solids or total residue)
Public Water	Tritium	Quarterly composite from weekly grab samples.	TBE, TBE-2011 Tritium analysis in drinking water by liquid scintillation  Env. Inc., T-02 Determination of tritium in water (direct method)
Fish	Gamma Spectroscopy	Semi-annual samples collected via electroshocking or other techniques	TBE-2007 Gamma emitting radioisotope analysis  Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Sediment	Gamma Spectroscopy	Semi-annual grab samples	TBE, TBE-2007 Gamma emitting radioisotope analysis  Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
Air Particulates	Gross Beta	One-week composite of continuous air sampling through glass fiber filter paper	TBE, TBE-2008 Gross Alpha and/or gross beta activity in various matrices  Env. Inc., AP-02 Determination of gross alpha and/or gross beta in air particulate filters
Air Particulates	Gamma Spectroscopy	Quarterly composite of each station	TBE, TBE-2007 Gamma emitting radioisotope analysis  Env. Inc., GS-01 Determination of gamma emitters by gamma spectroscopy
TLD	Thermoluminescence Dosimetry	Quarterly TLDs comprised of two CaF 200 and two LiF 100 LiF 4-chip Harshaw elements.	Mirion Technologies

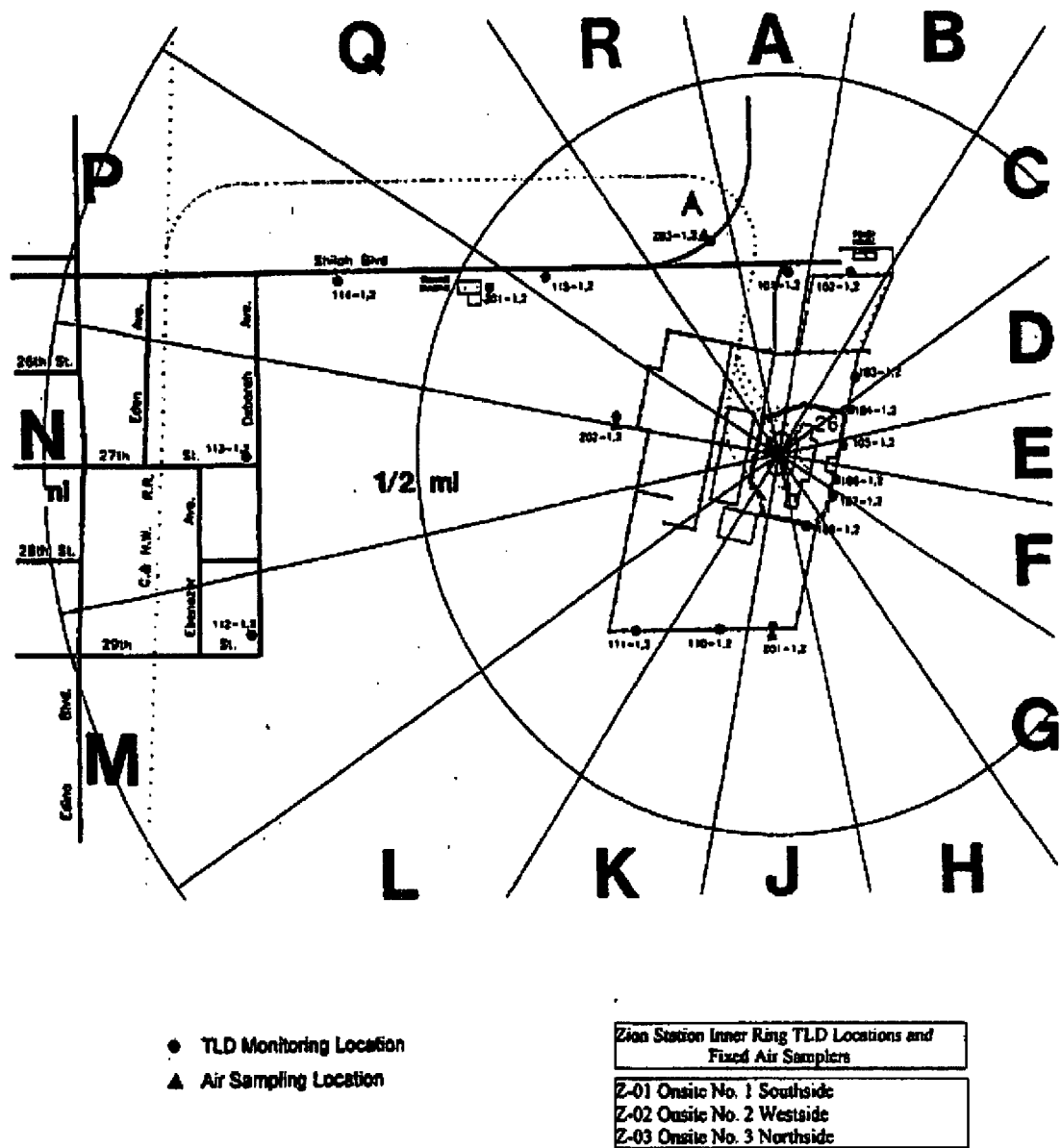


Figure B-1  
Inner Ring TLD Locations and Fixed Air Samplers of the Zion Nuclear Power Station, 2012

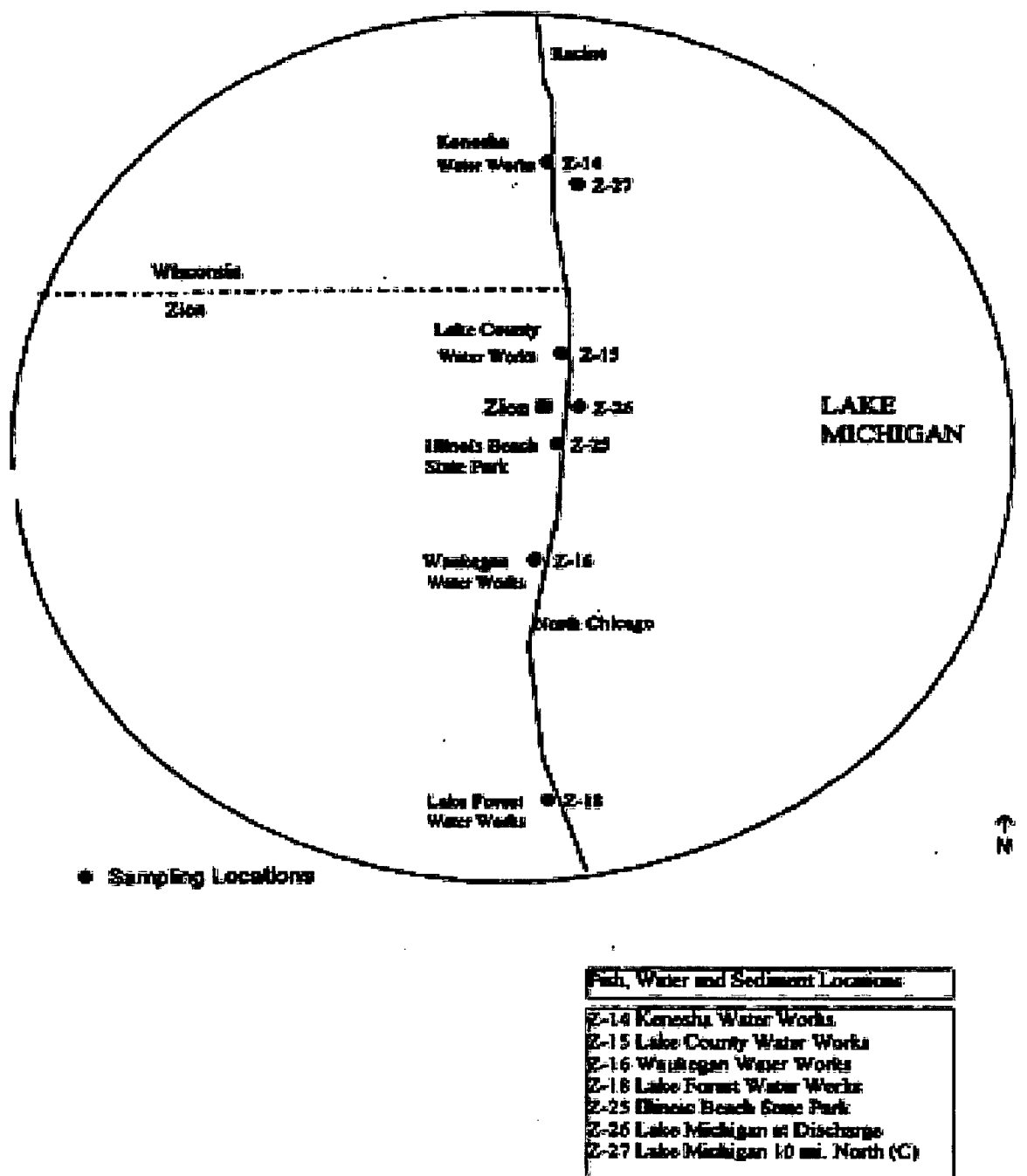


Figure B-2  
Fish, Water and Sediment Locations of the Zion Nuclear Power Station, 2012

## **APPENDIX C**

### **DATA TABLES AND FIGURES PRIMARY LABORATORY**

**TABLE C-I.1**                      **CONCENTRATIONS OF GROSS BETA IN PUBLIC WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

COLLECTION PERIOD	Z-14	Z-15	Z-16	Z-18
01/04/12 - 01/25/12	< 2.3	< 2.2	< 2.2	2.4 $\pm$ 1.5
02/01/12 - 02/29/12	4.5 $\pm$ 1.8	< 2.6	< 2.7	< 2.7
03/07/12 - 03/28/12	2.9 $\pm$ 1.1	3.9 $\pm$ 1.1	3.0 $\pm$ 1.1	2.2 $\pm$ 1.1
04/04/12 - 04/04/12	2.1 $\pm$ 1.0	2.7 $\pm$ 1.0	2.1 $\pm$ 1.0	1.8 $\pm$ 1.1
05/02/12 - 05/30/12	2.1 $\pm$ 1.0	2.6 $\pm$ 1.0	2.2 $\pm$ 1.0	2.1 $\pm$ 1.0
06/06/12 - 06/27/12	2.0 $\pm$ 1.1	< 1.7	2.6 $\pm$ 1.1	3.6 $\pm$ 1.2
07/05/12 - 07/25/12	< 1.6	< 1.6	2.1 $\pm$ 1.1	2.7 $\pm$ 1.2
08/01/12 - 08/29/12	2.5 $\pm$ 1.0	2.7 $\pm$ 1.1	2.6 $\pm$ 1.0	2.8 $\pm$ 1.1
09/05/12 - 09/26/12	< 2.1	2.3 $\pm$ 1.4	< 2.2	< 2.2
10/03/12 - 10/24/12	3.3 $\pm$ 1.1	2.3 $\pm$ 1.1	2.2 $\pm$ 1.1	3.4 $\pm$ 1.1
11/01/12 - 11/28/12	2.8 $\pm$ 1.1	2.1 $\pm$ 1.1	1.9 $\pm$ 1.1	2.4 $\pm$ 1.1
12/05/12 - 12/26/12	2.0 $\pm$ 1.0	1.8 $\pm$ 1.0	2.0 $\pm$ 1.1	1.7 $\pm$ 1.0
MEAN*	2.7 $\pm$ 1.7	2.6 $\pm$ 1.3	2.3 $\pm$ 0.7	2.5 $\pm$ 1.3

**TABLE C-I.2**                      **CONCENTRATIONS OF TRITIUM IN PUBLIC WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

COLLECTION PERIOD	Z-14	Z-15	Z-16	Z-18
01/04/12 - 03/28/12	< 166	< 164	< 168	< 163
04/04/12 - 06/27/12	< 151	< 149	< 184	< 148
07/05/12 - 09/26/12	< 162	< 159	< 159	< 159
10/03/12 - 12/26/12	< 173	< 180	< 182	< 181
MEAN	-	-	-	-

\* THE MEAN AND 2 STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES



TABLE C-I.3

**CONCENTRATIONS OF GAMMA EMITTERS IN PUBLIC WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Z-14	01/04/12 - 01/25/12	< 6	< 6	< 16	< 6	< 9	< 8	< 10	< 5	< 5	< 64	< 20
	02/01/12 - 02/29/12	< 4	< 5	< 9	< 4	< 8	< 5	< 8	< 4	< 4	< 41	< 12
	03/07/12 - 03/28/12	< 5	< 3	< 8	< 6	< 11	< 5	< 6	< 5	< 6	< 22	< 7
	04/04/12 - 04/04/12	< 4	< 5	< 13	< 4	< 8	< 5	< 10	< 4	< 4	< 102	< 29
	05/02/12 - 05/30/12	< 8	< 8	< 21	< 5	< 18	< 8	< 13	< 7	< 7	< 67	< 20
	06/06/12 - 06/27/12	< 4	< 5	< 13	< 5	< 10	< 6	< 9	< 4	< 4	< 72	< 18
	07/05/12 - 07/25/12	< 5	< 5	< 10	< 5	< 9	< 6	< 13	< 5	< 5	< 36	< 15
	08/01/12 - 08/29/12	< 4	< 5	< 10	< 3	< 9	< 5	< 9	< 3	< 4	< 53	< 21
	09/05/12 - 09/26/12	< 7	< 9	< 15	< 6	< 16	< 9	< 11	< 6	< 6	< 90	< 24
	10/03/12 - 10/24/12	< 4	< 4	< 10	< 4	< 7	< 6	< 8	< 4	< 3	< 78	< 23
	11/01/12 - 11/28/12	< 5	< 5	< 12	< 5	< 8	< 5	< 7	< 4	< 4	< 29	< 7
	12/05/12 - 12/26/12	< 5	< 5	< 16	< 6	< 13	< 7	< 9	< 5	< 5	< 39	< 16
	MEAN	-	-	-	-	-	-	-	-	-	-	-
Z-15	01/04/12 - 01/25/12	< 5	< 6	< 14	< 5	< 12	< 7	< 10	< 5	< 5	< 61	< 16
	02/01/12 - 02/29/12	< 5	< 5	< 13	< 5	< 11	< 6	< 7	< 4	< 5	< 51	< 16
	03/07/12 - 03/28/12	< 4	< 4	< 9	< 4	< 8	< 5	< 8	< 4	< 5	< 22	< 8
	04/04/12 - 04/04/12	< 5	< 6	< 16	< 5	< 10	< 7	< 14	< 6	< 5	< 139	< 45
	05/02/12 - 05/30/12	< 6	< 8	< 14	< 7	< 14	< 7	< 14	< 6	< 9	< 63	< 18
	06/06/12 - 06/27/12	< 4	< 5	< 13	< 3	< 10	< 6	< 10	< 4	< 4	< 59	< 19
	07/05/12 - 07/25/12	< 6	< 6	< 14	< 5	< 11	< 6	< 10	< 6	< 6	< 52	< 18
	08/01/12 - 08/29/12	< 4	< 5	< 14	< 4	< 11	< 6	< 10	< 5	< 5	< 74	< 18
	09/05/12 - 09/26/12	< 6	< 7	< 12	< 6	< 13	< 6	< 15	< 5	< 6	< 96	< 22
	10/03/12 - 10/24/12	< 5	< 6	< 15	< 5	< 11	< 8	< 12	< 4	< 6	< 107	< 31
	11/01/12 - 11/28/12	< 5	< 5	< 14	< 5	< 11	< 5	< 8	< 4	< 5	< 37	< 10
	12/05/12 - 12/26/12	< 5	< 6	< 11	< 4	< 11	< 5	< 9	< 4	< 5	< 36	< 13
	MEAN	-	-	-	-	-	-	-	-	-	-	-

TABLE C-I.3

**CONCENTRATIONS OF GAMMA EMITTERS IN PUBLIC WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Z-16	01/04/12 - 01/25/12	< 5	< 6	< 14	< 5	< 11	< 7	< 11	< 5	< 5	< 58	< 21
	02/01/12 - 02/29/12	< 3	< 5	< 12	< 4	< 10	< 5	< 8	< 4	< 4	< 38	< 14
	03/07/12 - 03/28/12	< 5	< 5	< 11	< 4	< 8	< 5	< 9	< 5	< 5	< 24	< 7
	04/04/12 - 04/04/12	< 5	< 6	< 15	< 6	< 9	< 6	< 11	< 4	< 5	< 98	< 26
	05/02/12 - 05/30/12	< 7	< 8	< 20	< 6	< 12	< 7	< 12	< 5	< 6	< 39	< 21
	06/06/12 - 06/27/12	< 5	< 5	< 15	< 5	< 12	< 5	< 11	< 5	< 4	< 66	< 22
	07/05/12 - 07/25/12	< 5	< 6	< 12	< 6	< 8	< 7	< 10	< 5	< 5	< 48	< 16
	08/01/12 - 08/29/12	< 4	< 5	< 11	< 4	< 8	< 6	< 9	< 4	< 5	< 62	< 20
	09/05/12 - 09/26/12	< 4	< 6	< 15	< 5	< 9	< 6	< 11	< 5	< 5	< 82	< 31
	10/03/12 - 10/24/12	< 4	< 5	< 11	< 5	< 9	< 7	< 10	< 4	< 4	< 79	< 21
	11/01/12 - 11/28/12	< 5	< 5	< 10	< 5	< 8	< 5	< 8	< 4	< 5	< 31	< 10
	12/05/12 - 12/26/12	< 6	< 6	< 14	< 5	< 11	< 7	< 12	< 4	< 5	< 45	< 20
	MEAN	-	-	-	-	-	-	-	-	-	-	-
Z-18	01/04/12 - 01/25/12	< 4	< 4	< 11	< 5	< 6	< 6	< 10	< 4	< 5	< 48	< 17
	02/01/12 - 02/29/12	< 5	< 6	< 11	< 5	< 11	< 6	< 11	< 5	< 5	< 46	< 17
	03/07/12 - 03/28/12	< 5	< 5	< 11	< 5	< 7	< 5	< 8	< 4	< 6	< 25	< 7
	04/04/12 - 04/04/12	< 6	< 7	< 21	< 6	< 14	< 8	< 14	< 5	< 6	< 134	< 42
	05/02/12 - 05/30/12	< 6	< 6	< 10	< 4	< 9	< 5	< 8	< 5	< 4	< 50	< 19
	06/06/12 - 06/27/12	< 4	< 6	< 13	< 5	< 9	< 6	< 13	< 4	< 4	< 75	< 23
	07/05/12 - 07/25/12	< 6	< 6	< 12	< 5	< 11	< 6	< 12	< 6	< 7	< 51	< 13
	08/01/12 - 08/29/12	< 5	< 6	< 15	< 5	< 10	< 7	< 12	< 5	< 5	< 68	< 24
	09/05/12 - 09/26/12	< 6	< 6	< 16	< 6	< 11	< 6	< 15	< 5	< 6	< 106	< 30
	10/03/12 - 10/24/12	< 4	< 5	< 11	< 3	< 8	< 6	< 7	< 4	< 4	< 85	< 22
	11/01/12 - 11/28/12	< 5	< 6	< 10	< 6	< 11	< 6	< 9	< 4	< 5	< 33	< 11
	12/05/12 - 12/26/12	< 6	< 5	< 12	< 6	< 11	< 5	< 11	< 5	< 5	< 50	< 16
	MEAN	-	-	-	-	-	-	-	-	-	-	-

TABLE C-II.1

**CONCENTRATIONS OF GAMMA EMITTERS IN FISH SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/KG WET  $\pm$  2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
<b>Z-26</b>												
Common Carp	05/24/12	< 39	< 37	< 86	< 41	< 90	< 35	< 59	< 32	< 28	< 366	< 100
Smallmouth Bass	05/24/12	< 55	< 53	< 108	< 57	< 94	< 69	< 110	< 51	< 59	< 502	< 158
Chinook Salmon	10/22/12	< 38	< 38	< 67	< 40	< 80	< 47	< 71	< 36	< 50	< 320	< 72
Common Carp	10/22/12	< 44	< 51	< 100	< 50	< 108	< 65	< 70	< 53	< 58	< 415	< 135
	MEAN	-	-	-	-	-	-	-	-	-	-	-
<b>Z-27</b>												
Lake Trout	05/15/12	< 59	< 62	< 195	< 58	< 148	< 74	< 140	< 48	< 73	< 947	< 368
Burbot	05/15/12	< 47	< 53	< 96	< 44	< 69	< 56	< 85	< 42	< 62	< 837	< 166
Lake Trout	10/18/12	< 44	< 47	< 95	< 53	< 64	< 56	< 93	< 40	< 67	< 446	< 137
Burbot	10/18/12	< 49	< 43	< 118	< 43	< 100	< 61	< 98	< 43	< 46	< 452	< 139
	MEAN	-	-	-	-	-	-	-	-	-	-	-

**TABLE C-III.1      CONCENTRATIONS OF GAMMMA EMITTERS IN SEDIMENT SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/KG DRY ± 2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Z-25	05/09/12	< 42	< 39	< 89	< 36	< 92	< 43	< 70	< 39	< 48	< 210	< 58
	10/17/12	< 23	< 29	< 67	< 34	< 59	< 33	< 48	< 28	< 30	< 173	< 51
	MEAN	-	-	-	-	-	-	-	-	-	-	-

**TABLE C-IV.1 CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATE SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF E-3 PCI/CU METER  $\pm$  2 SIGMA

COLLECTION PERIOD	GROUP I		
	Z-01	Z-02	Z-03
12/28/11 - 01/04/12	25 $\pm$ 5	17 $\pm$ 4	20 $\pm$ 4
01/04/12 - 01/11/12	22 $\pm$ 5	21 $\pm$ 5	27 $\pm$ 5
01/11/12 - 01/18/12	23 $\pm$ 5	20 $\pm$ 4	23 $\pm$ 4
01/18/12 - 01/25/12	21 $\pm$ 5	18 $\pm$ 4	23 $\pm$ 5
01/25/12 - 02/01/12	23 $\pm$ 5	19 $\pm$ 4	18 $\pm$ 4
02/01/12 - 02/09/12	18 $\pm$ 4	17 $\pm$ 4	16 $\pm$ 4
02/09/12 - 02/15/12	13 $\pm$ 4	10 $\pm$ 4	15 $\pm$ 4
02/15/12 - 02/22/12	21 $\pm$ 4	20 $\pm$ 4	21 $\pm$ 4
02/22/12 - 02/29/12	23 $\pm$ 5	21 $\pm$ 5	19 $\pm$ 5
02/29/12 - 03/07/12	14 $\pm$ 4	17 $\pm$ 4	19 $\pm$ 4
03/07/12 - 03/14/12	19 $\pm$ 4	16 $\pm$ 4	14 $\pm$ 4
03/14/12 - 03/21/12	19 $\pm$ 5	15 $\pm$ 4	16 $\pm$ 4
03/21/12 - 03/28/12	17 $\pm$ 4	13 $\pm$ 4	11 $\pm$ 4
03/28/12 - 04/04/12	8 $\pm$ 4	10 $\pm$ 4	7 $\pm$ 4
04/04/12 - 04/11/12	12 $\pm$ 4	13 $\pm$ 4	12 $\pm$ 4
04/11/12 - 04/18/12	18 $\pm$ 4	11 $\pm$ 4	17 $\pm$ 4
04/18/12 - 04/25/12	14 $\pm$ 4	10 $\pm$ 5	8 $\pm$ 4
04/25/12 - 05/02/12	18 $\pm$ 5	16 $\pm$ 4	20 $\pm$ 5
05/02/12 - 05/09/12	12 $\pm$ 4	7 $\pm$ 3	9 $\pm$ 3
05/09/12 - 05/16/12	10 $\pm$ 5	8 $\pm$ 4	10 $\pm$ 5
05/16/12 - 05/23/12	15 $\pm$ 4	12 $\pm$ 4	8 $\pm$ 4
05/23/12 - 05/30/12	15 $\pm$ 4	15 $\pm$ 4	10 $\pm$ 4
05/30/12 - 06/06/12	7 $\pm$ 4	6 $\pm$ 4	< 6
06/06/12 - 06/13/12	10 $\pm$ 4	15 $\pm$ 4	9 $\pm$ 4
06/13/12 - 06/20/12	18 $\pm$ 4	18 $\pm$ 4	14 $\pm$ 4
06/20/12 - 06/27/12	9 $\pm$ 3	13 $\pm$ 4	15 $\pm$ 4
06/27/12 - 07/05/12	26 $\pm$ 4	24 $\pm$ 4	23 $\pm$ 4
07/05/12 - 07/11/12	15 $\pm$ 5	11 $\pm$ 5	15 $\pm$ 5
07/11/12 - 07/18/12	21 $\pm$ 4	13 $\pm$ 4	19 $\pm$ 4
07/18/12 - 07/25/12	20 $\pm$ 4	14 $\pm$ 4	19 $\pm$ 4
07/25/12 - 08/01/12	14 $\pm$ 4	10 $\pm$ 4	9 $\pm$ 4
08/01/12 - 08/08/12	24 $\pm$ 4	20 $\pm$ 4	19 $\pm$ 4
08/08/12 - 08/15/12	14 $\pm$ 4	12 $\pm$ 4	14 $\pm$ 4
08/15/12 - 08/22/12	11 $\pm$ 4	15 $\pm$ 4	16 $\pm$ 4
08/22/12 - 08/29/12	29 $\pm$ 5	19 $\pm$ 4	31 $\pm$ 5
08/29/12 - 09/05/12	21 $\pm$ 4	18 $\pm$ 4	20 $\pm$ 4
09/05/12 - 09/12/12	18 $\pm$ 4	17 $\pm$ 4	18 $\pm$ 4
09/12/12 - 09/19/12	24 $\pm$ 4	17 $\pm$ 4	18 $\pm$ 4
09/19/12 - 09/26/12	16 $\pm$ 5	15 $\pm$ 4	10 $\pm$ 4
09/26/12 - 10/03/12	20 $\pm$ 4	14 $\pm$ 4	17 $\pm$ 4
10/03/12 - 10/10/12	17 $\pm$ 4	21 $\pm$ 4	15 $\pm$ 4
10/10/12 - 10/17/12	16 $\pm$ 4	19 $\pm$ 4	17 $\pm$ 4
10/17/12 - 10/24/12	19 $\pm$ 4	21 $\pm$ 4	20 $\pm$ 4
10/24/12 - 11/01/12	13 $\pm$ 4	16 $\pm$ 4	14 $\pm$ 4
11/01/12 - 11/08/12	21 $\pm$ 5	22 $\pm$ 5	23 $\pm$ 5
11/08/12 - 11/14/12	26 $\pm$ 5	22 $\pm$ 5	22 $\pm$ 5
11/14/12 - 11/21/12	42 $\pm$ 5	41 $\pm$ 5	38 $\pm$ 5
11/21/12 - 11/28/12	34 $\pm$ 5	32 $\pm$ 5	34 $\pm$ 5
11/28/12 - 12/05/12	27 $\pm$ 6	25 $\pm$ 6	22 $\pm$ 6
12/05/12 - 12/12/12	< 4	17 $\pm$ 4	19 $\pm$ 4
12/12/12 - 12/19/12	39 $\pm$ 5	31 $\pm$ 5	32 $\pm$ 5
12/19/12 - 12/26/12	26 $\pm$ 5	27 $\pm$ 5	25 $\pm$ 5
12/26/12 - 01/02/13	32 $\pm$ 5	36 $\pm$ 6	32 $\pm$ 5
MEAN	19 $\pm$ 15	17 $\pm$ 14	18 $\pm$ 14

\* THE MEAN AND 2 STANDARD DEVIATION ARE CALCULATED USING THE POSITIVE VALUES

TABLE C-IV.2

**MONTHLY AND YEARLY MEAN VALUES OF GROSS BETA CONCENTRATIONS IN  
AIR PARTICULATE SAMPLES COLLECTED IN THE VICINITY OF ZION NUCLEAR  
POWER STATION, 2012**

RESULTS IN UNITS OF E-3 PCI/CU METER  $\pm$  2 SIGMA

GROUP I - ONSITE LOCATIONS

COLLECTION PERIOD	MIN	MAX	MEAN $\pm$ 2SD
01/04/12 - 02/01/12	18	27	21 $\pm$ 5
02/01/12 - 02/29/12	10	23	18 $\pm$ 7
02/29/12 - 03/28/12	11	19	16 $\pm$ 5
03/28/12 - 05/02/12	7	20	13 $\pm$ 8
05/02/12 - 05/30/12	7	15	11 $\pm$ 6
05/30/12 - 06/27/12	6	18	12 $\pm$ 8
06/27/12 - 08/01/12	9	26	17 $\pm$ 10
08/01/12 - 08/29/12	11	31	19 $\pm$ 13
08/29/12 - 10/03/12	10	24	17 $\pm$ 6
10/03/12 - 11/01/12	13	21	17 $\pm$ 5
11/01/12 - 11/28/12	21	42	30 $\pm$ 16
12/28/11 - 01/02/13	17	39	26 $\pm$ 13
12/28/11 - 01/02/13	6	42	18 $\pm$ 14

TABLE C-IV.3

**CONCENTRATIONS OF GAMMA EMITTERS IN AIR PARTICULATE SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF E-3 PCI/CU METER  $\pm$  2 SIGMA

SITE	COLLECTION PERIOD	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
Z-01	12/28/11 - 03/28/12	< 3	< 4	< 8	< 3	< 7	< 4	< 6	< 3	< 3	< 53	< 8
	03/28/12 - 06/27/12	< 3	< 3	< 11	< 3	< 9	< 4	< 6	< 4	< 3	< 57	< 24
	06/27/12 - 09/26/12	< 3	< 4	< 10	< 3	< 7	< 5	< 7	< 3	< 3	< 110	< 64
	09/26/12 - 01/02/13	< 3	< 3	< 7	< 3	< 6	< 3	< 6	< 2	< 2	< 33	< 14
	MEAN	-	-	-	-	-	-	-	-	-	-	-
Z-02	12/28/11 - 03/28/12	< 3	< 4	< 11	< 4	< 7	< 3	< 8	< 3	< 4	< 76	< 24
	03/28/12 - 06/27/12	< 3	< 5	< 8	< 3	< 7	< 4	< 5	< 3	< 2	< 60	< 32
	06/27/12 - 09/26/12	< 3	< 4	< 15	< 3	< 9	< 5	< 11	< 4	< 3	< 200	< 73
	09/26/12 - 01/02/13	< 3	< 3	< 6	< 2	< 5	< 3	< 5	< 2	< 2	< 29	< 8
	MEAN	-	-	-	-	-	-	-	-	-	-	-
Z-03	12/28/11 - 03/28/12	< 2	< 3	< 4	< 1	< 5	< 2	< 5	< 2	< 2	< 42	< 16
	03/28/12 - 06/27/12	< 3	< 3	< 9	< 3	< 6	< 3	< 6	< 3	< 2	< 61	< 16
	06/27/12 - 09/26/12	< 3	< 3	< 9	< 2	< 5	< 3	< 6	< 2	< 2	< 134	< 32
	09/26/12 - 01/02/13	< 1	< 2	< 4	< 2	< 4	< 2	< 3	< 2	< 1	< 21	< 7
	MEAN	-	-	-	-	-	-	-	-	-	-	-

**TABLE C-V.1 QUARTERLY TLD RESULTS FOR ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF MILLI-ROENTGEN/QUARTER  $\pm 2$  STANDARD DEVIATIONS

STATION CODE	MEAN $\pm 2$ S.D.	JAN - MAR	APR - JUN	JUL - SEP	OCT - DEC
Z-01-1	20.3 $\pm$ 3.4	20	18	21	22
Z-01-2	20.8 $\pm$ 2.5	21	19	21	22
Z-02-1	19.0 $\pm$ 3.3	19	17	19	21
Z-02-2	18.8 $\pm$ 1.9	18	18	19	20
Z-03-1	20.0 $\pm$ 1.6	20	19	20	21
Z-03-2	20.8 $\pm$ 6.2	21	18	19	25
Z-101-1	18.5 $\pm$ 3.5	19	16	19	20
Z-101-2	20.5 $\pm$ 3.8	21	23	19	19
Z-102-1	21.8 $\pm$ 6.2	22	20	19	26
Z-102-2	21.0 $\pm$ 4.3	22	18	21	23
Z-103-1	19.5 $\pm$ 3.5	21	17	20	20
Z-103-2	20.0 $\pm$ 3.3	20	18	20	22
Z-104-1	20.5 $\pm$ 5.3	24	18	19	21
Z-104-2	20.8 $\pm$ 7.7	25	17	18	23
Z-105-1	20.3 $\pm$ 4.7	22	17	20	22
Z-105-2	19.8 $\pm$ 4.1	22	17	20	20
Z-106-1	19.3 $\pm$ 6.0	20	16	18	23
Z-106-2	20.0 $\pm$ 3.7	21	18	19	22
Z-107-1	21.5 $\pm$ 5.0	22	18	24	22
Z-107-2	20.5 $\pm$ 6.2	24	17	19	22
Z-108-1	27.0 $\pm$ 23.2	22	18	24	44
Z-108-2	26.8 $\pm$ 24.8	20	18	24	45
Z-110-1	20.5 $\pm$ 2.0	20	20	20	22
Z-110-2	20.5 $\pm$ 2.6	21	19	20	22
Z-111-1	19.3 $\pm$ 4.1	19	17	19	22
Z-111-2	19.0 $\pm$ 3.3	19	17	19	21
Z-112-1	20.5 $\pm$ 2.6	21	19	20	22
Z-112-2	21.0 $\pm$ 2.8	21	19	22	22
Z-113-1	19.3 $\pm$ 3.4	20	17	19	21
Z-113-2	19.3 $\pm$ 3.4	20	17	19	21
Z-114-1	20.8 $\pm$ 6.0	20	18	20	25
Z-114-2	21.0 $\pm$ 1.6	21	20	21	22
Z-115-1	20.5 $\pm$ 4.2	21	18	20	23
Z-115-2	21.8 $\pm$ 4.1	24	19	22	22
Z-301-1	20.0 $\pm$ 2.8	21	18	20	21
Z-301-2	21.5 $\pm$ 1.2	21	22	21	22



**TABLE C-V.2 MEAN QUARTERLY TLD RESULTS FOR INNER RING AND OTHER LOCATIONS FOR ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF MILLI-ROENTGEN/QUARTER  
STANDARD DEVIATIONS OF THE STATION DATA

COLLECTION PERIOD	INNER RING ± 2 S.D.	OTHER
JAN-MAR	21.2 ± 3.0	19.8 ± 2.3
APR-JUN	18.2 ± 3.2	18.2 ± 1.5
JUL-SEP	20.2 ± 3.2	19.8 ± 2.0
OCT-DEC	23.4 ± 11.8	21.8 ± 3.4

**TABLE C-V.3 SUMMARY OF THE AMBIENT DOSIMETRY PROGRAM FOR ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF MILLI-ROENTGEN/QUARTER

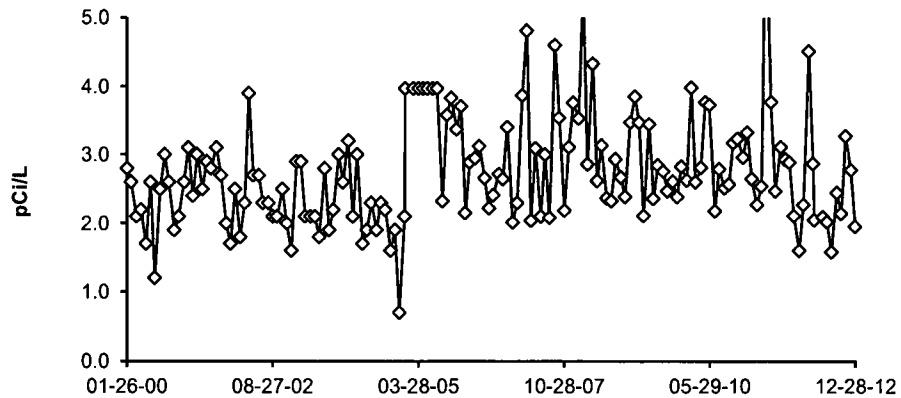
LOCATION	SAMPLES ANALYZED	PERIOD MINIMUM	PERIOD MAXIMUM	PERIOD MEAN ± 2 S.D.
INNER RING	120	16	45	20.7 ± 7.4
OTHER	24	17	25	19.9 ± 3.5

INNER RING STATIONS - Z-101-1, Z-101-2, Z-102-1, Z-102-2, Z-103-1, Z-103-2, Z-104-1, Z-104-2, Z-105-1, Z-105-2, Z-106-1, Z-106-2, Z-107-1, Z-107-2, Z-108-1, Z-108-2, Z-110-1, Z-110-2, Z-111-1, Z-111-2, Z-112-1, Z-112-2, Z-113-1, Z-113-2, Z-114-1, Z-114-2, Z-115-1, Z-115-2, Z-301-1, Z-301-2

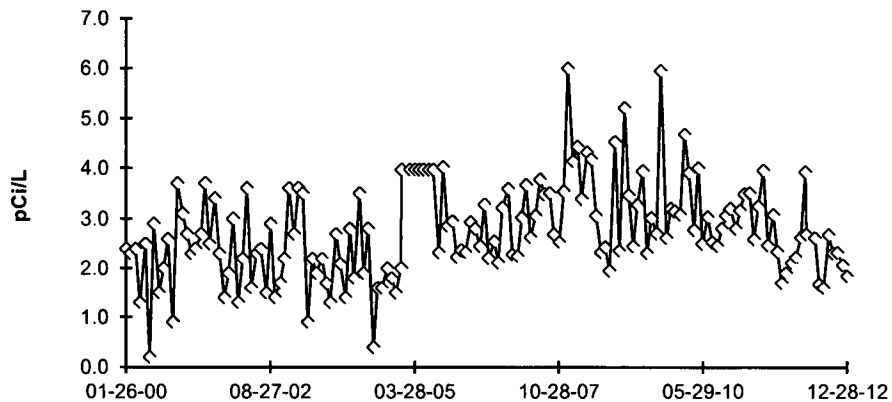
OTHER STATIONS - Z-01-1, Z-01-2, Z-02-1, Z-02-2, Z-03-1, Z-03-2

**FIGURE C-1**  
**PUBLIC WATER - GROSS BETA - STATIONS Z-14 AND**  
**Z-15 COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-14 (C) Kenosha Water Works**



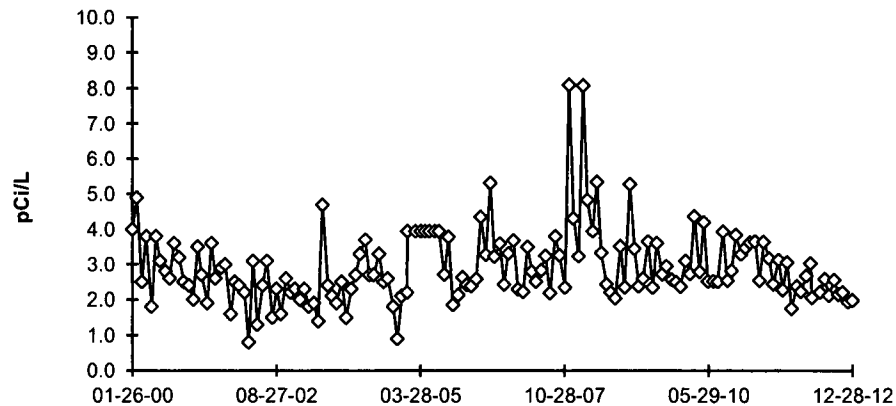
**Z-15 Lake County Water Works**



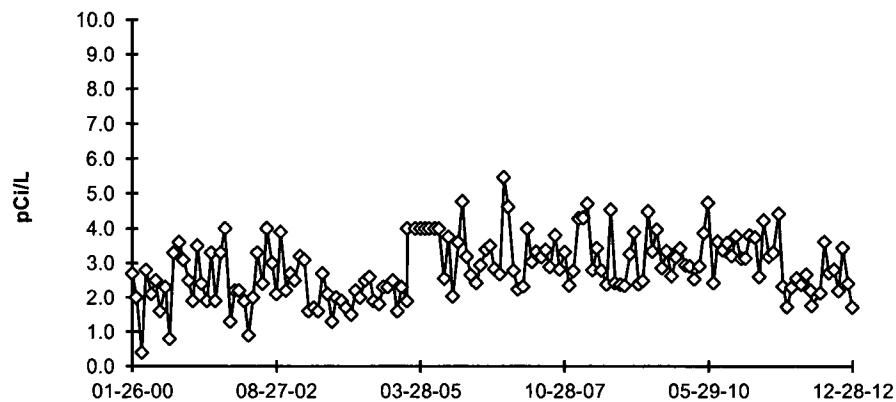
DUE TO VENDOR CHANGE IN 2005, < VALUES ARE LLD VALUES JANUARY THROUGH JUNE 2005 AND MDC VALUES AFTER JUNE 2005

**FIGURE C-2**  
**PUBLIC WATER - GROSS BETA - STATIONS Z-16 AND**  
**Z-18 COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-16 Waukegan Water Works**



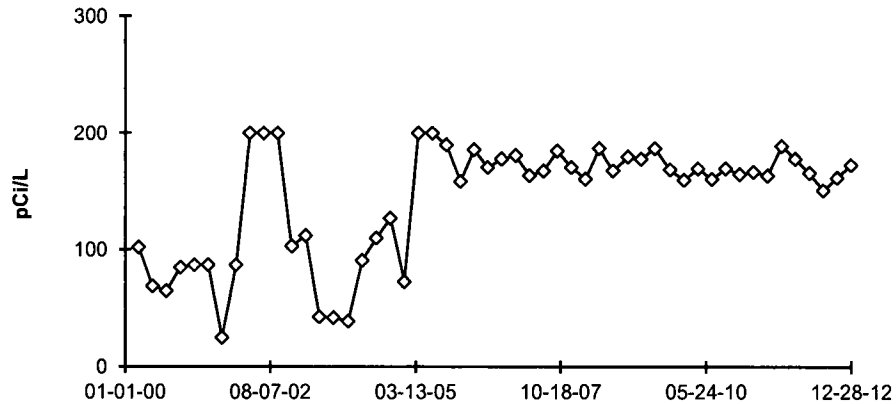
**Z-18 (C) Lake Forest Water Works**



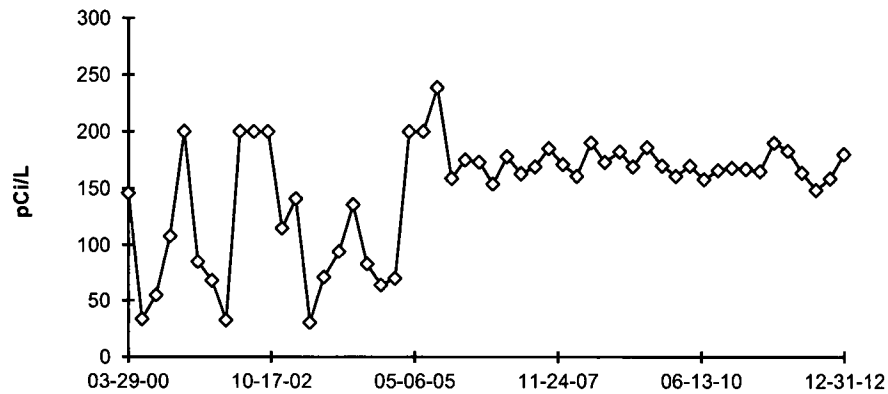
DUE TO VENDOR CHANGE IN 2005, < VALUES ARE LLD VALUES JANUARY THROUGH JUNE 2005 AND MDC VALUES AFTER JUNE 2005

# **FIGURE C-3** **PUBLIC WATER - TRITIUM - STATION Z-14 AND Z-15** **COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-14 (C) Kenosha Water Works**



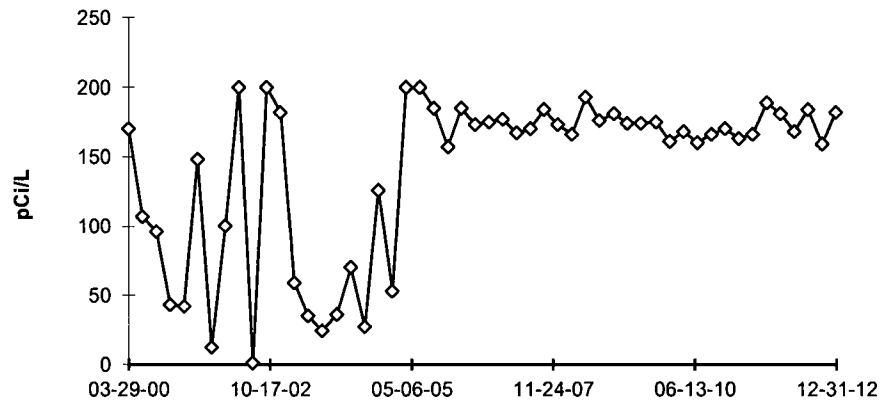
**Z-15 Lake County Water Works**



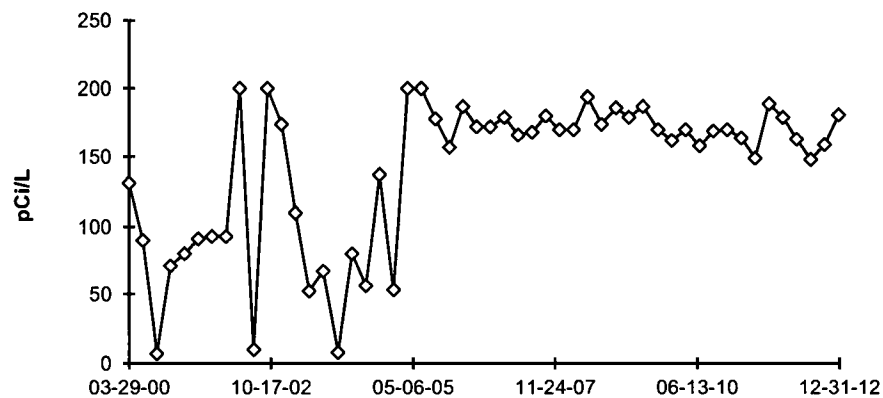
DUE TO VENDOR CHANGE IN 2005, < VALUES ARE LLD VALUES JANUARY THROUGH JUNE 2005 AND MDC VALUES AFTER JUNE 2005

**FIGURE C-4**  
**PUBLIC WATER - TRITIUM - STATION Z-16 AND Z-18**  
**COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-16 Waukegan Water Works**



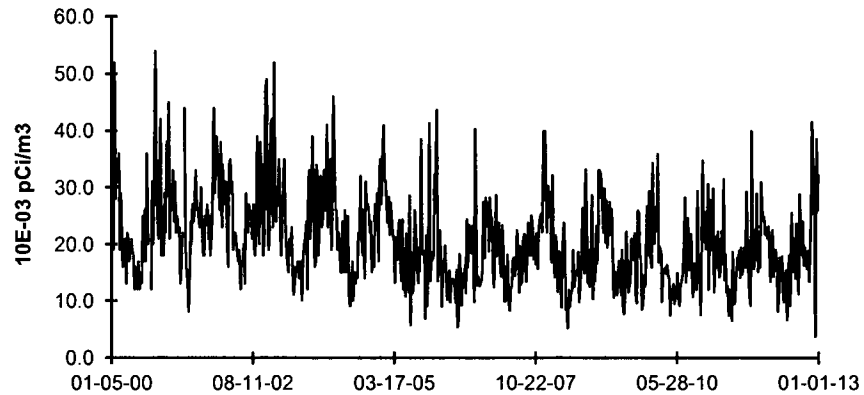
**Z-18 (C) Lake Forest Water Works**



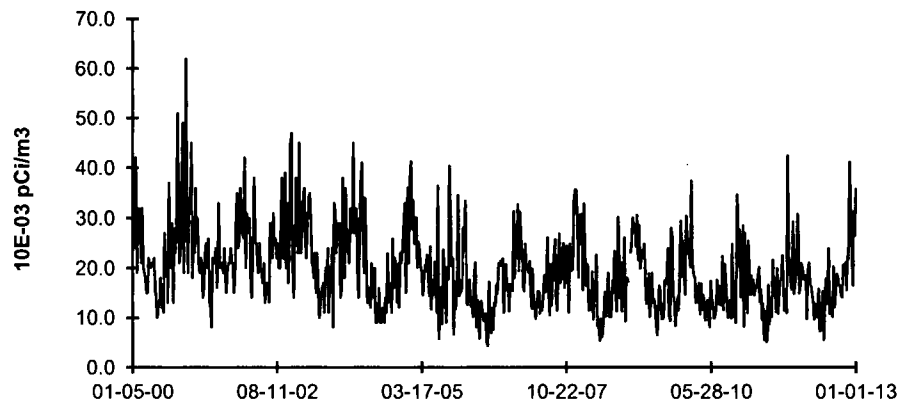
DUE TO VENDOR CHANGE IN 2005, < VALUES ARE LLD VALUES JANUARY THROUGH JUNE 2005 AND MDC VALUES AFTER JUNE 2005

**FIGURE C-5**  
**AIR PARTICULATES - GROSS BETA - STATIONS Z-01 AND**  
**Z-02 COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-01 Onsite No. 1, Southside**

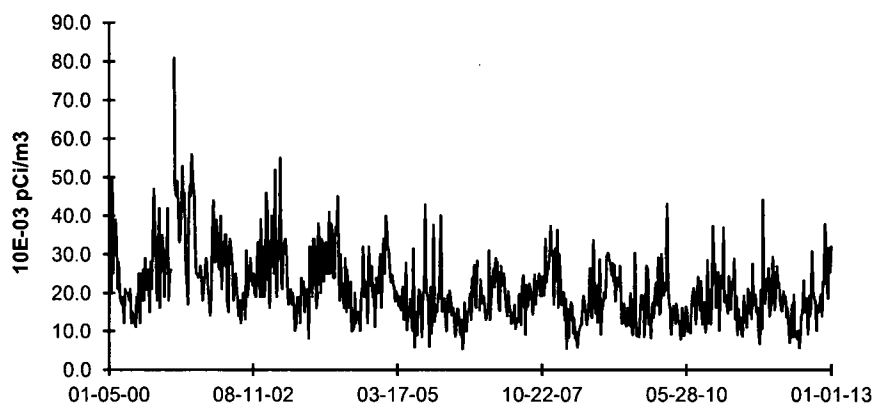


**Z-02 Onsite No. 2, Westside**



**FIGURE C-6**  
**AIR PARTICULATES - GROSS BETA - STATIONS Z-03**  
**COLLECTED IN THE VICINITY OF ZNPS, 2000 - 2012**

**Z-03 Onsite No. 3, Northside**



## **APPENDIX D**

### **INTER-LABORATORY COMPARISON PROGRAM**



**TABLE D-1 ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 1 OF 3)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2012	E10066	Milk	Sr-89	pCi/L	101	94.8	1.07	A
			Sr-90	pCi/L	11.7	13.5	0.87	A
	E10067	Milk	I-131	pCi/L	87.5	92.5	0.95	A
			Ce-141	pCi/L	247	260	0.95	A
			Cr-51	pCi/L	435	436	1.00	A
			Cs-134	pCi/L	133	149	0.89	A
			Cs-137	pCi/L	156	159	0.98	A
			Co-58	pCi/L	127	132	0.96	A
			Mn-54	pCi/L	190	195	0.97	A
			Fe-59	pCi/L	179	168	1.07	A
			Zn-65	pCi/L	327	333	0.98	A
			Co-60	pCi/L	274	279	0.98	A
	E10069	AP	Ce-141	pCi	167	164	1.02	A
			Cr-51	pCi	310	276	1.12	A
			Cs-134	pCi	107	94.5	1.13	A
			Cs-137	pCi	109	101	1.08	A
			Co-58	pCi	87.6	83.5	1.05	A
			Mn-54	pCi	133	123	1.08	A
			Fe-59	pCi	113	106	1.07	A
			Zn-65	pCi	226	210	1.08	A
			Co-60	pCi	185	176	1.05	A
	E10068	Charcoal	I-131	pCi	92.8	94.2	0.99	A
	E10070	Water	Fe-55	pCi/L	1800	1570	1.15	A
June 2012	E10198	Milk	Sr-89	pCi/L	86.1	99.8	0.86	A
			Sr-90	pCi/L	9.2	12.7	0.72	W
	E10199	Milk	I-131	pCi/L	88.9	99.7	0.89	A
			Ce-141	pCi/L	72.8	82.2	0.89	A
			Cr-51	pCi/L	394	402	0.98	A
			Cs-134	pCi/L	159	174	0.91	A
			Cs-137	pCi/L	206	212	0.97	A
			Co-58	pCi/L	89.5	92.3	0.97	A
			Mn-54	pCi/L	129	132	0.98	A
			Fe-59	pCi/L	129	128	1.01	A
			Zn-65	pCi/L	193	199	0.97	A
			Co-60	pCi/L	342	355	0.96	A
	E10201	AP	Ce-141	pCi	73.2	75.1	0.97	A
			Cr-51	pCi	367	366	1.00	A
			Cs-134	pCi	165	159	1.04	A
			Cs-137	pCi	205	193	1.06	A
			Co-58	pCi	84.7	84.2	1.01	A
			Mn-54	pCi	118	121	0.98	A
			Fe-59	pCi	125	117	1.07	A
			Zn-65	pCi	181	182	0.99	A
			Co-60	pCi	338	324	1.04	A
	E10200	Charcoal	I-131	pCi	101	96.6	1.05	A

**TABLE D-1 ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 2 OF 3)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
June 2012	E10202	Water	Fe-55	pCi/L	1890	1580	1.20	A
September 2012	E10296	Milk	Sr-89	pCi/L	106	99.6	1.06	A
			Sr-90	pCi/L	13.6	16.0	0.85	A
	E10297	Milk	I-131	pCi/L	89.8	99.6	0.90	A
			Ce-141	pCi/L	160	164	0.98	A
			Cr-51	pCi/L	230	248	0.93	A
			Cs-134	pCi/L	101	108	0.94	A
			Cs-137	pCi/L	174	174	1.00	A
			Co-58	pCi/L	97.2	100	0.97	A
			Mn-54	pCi/L	188	196	0.96	A
			Fe-59	pCi/L	159	152	1.05	A
			Zn-65	pCi/L	195	192	1.02	A
			Co-60	pCi/L	155	152	1.02	A
	E10299	AP	Ce-141	pCi	145	135	1.07	A
			Cr-51	pCi	219	205	1.07	A
			Cs-134	pCi	94.1	89.4	1.05	A
			Cs-137	pCi	140	144	0.97	A
			Co-58	pCi	88.3	83.0	1.06	A
			Mn-54	pCi	173	162	1.07	A
			Fe-59	pCi	136	125	1.09	A
			Zn-65	pCi	165	159	1.04	A
			Co-60	pCi	133	125	1.06	A
	E10298	Charcoal	I-131	pCi	95.5	97.2	0.98	A
	E10300	Water	Fe-55	pCi/L	1630	1900	0.86	A
December 2012	E10334	Milk	Sr-89	pCi/L	101	96.6	1.05	A
			Sr-90	pCi/L	11.3	13.8	0.82	A
	E10335	Milk	I-131	pCi/L	93.1	90.0	1.03	A
			Ce-141	pCi/L	52.5	51.0	1.03	A
			Cr-51	pCi/L	373	348	1.07	A
			Cs-134	pCi/L	157	165	0.95	A
			Cs-137	pCi/L	113	117	0.97	A
			Co-58	pCi/L	94.1	98.5	0.96	A
			Mn-54	pCi/L	116	116	1.00	A
			Fe-59	pCi/L	124	116	1.07	A
			Zn-65	pCi/L	190	186	1.02	A
			Co-60	pCi/L	172	170	1.01	A
	E10337A	AP	Ce-141	pCi	51.8	49.6	1.04	A
			Cr-51	pCi	372	338	1.10	A
			Cs-134	pCi	165	161	1.02	A
			Cs-137	pCi	113	114	0.99	A
			Co-58	pCi	96.5	95.8	1.01	A
			Mn-54	pCi	118	112	1.05	A
			Fe-59	pCi	105	112	0.94	A
			Zn-65	pCi	166	181	0.92	A
			Co-60	pCi	179	165	1.08	A

**TABLE D-1**                      **ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 3 OF 3)

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2012	E10336	Charcoal	I-131	pCi	73.1	72.7	1.01	A
	E10333	Water	Fe-55	pCi/L	1550	1750	0.89	A

(a) Teledyne Brown Engineering reported result.

(b) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) Analytics evaluation based on TBE internal QC limits: A= Acceptable. Reported result falls within ratio limits of 0.80-1.20. W-Acceptable with warning. Reported result falls within 0.70-0.80 or 1.20-1.30. N = Not Acceptable. Reported result falls outside the ratio limits of < 0.70 and > 1.30.

**TABLE D-2**                      **ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 1 OF 1)

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2012	RAD-89	Water	Sr-89	pCi/L	63.4	58.5	46.9 - 66.3	A
			Sr-90	pCi/L	33.5	37.4	27.4 - 43.1	A
			Ba-133	pCi/L	89.2	82.3	69.1 - 90.5	A
			Cs-134	pCi/L	66.5	74.2	60.6 - 81.6	A
			Cs-137	pCi/L	152	155	140 - 172	A
			Co-60	pCi/L	73.3	72.9	65.6 - 82.6	A
			Zn-65	pCi/L	109	105	94.5 - 125	A
			Gr-A	pCi/L	82.4	62.9	33.0 - 78.0	N (1)
			Gr-B	pCi/L	43.6	44.2	29.6 - 51.5	A
			I-131	pCi/L	25.9	27.1	22.5 - 31.9	A
			H-3	pCi/L	15433	15800	13800 - 17400	A
	MRAD-16	Filter	Gr-A	pCi/filter	39.5	77.8	26.1 - 121	A
November, 2012	RAD-91	Water	Sr-89	pCi/L	46.5	39.1	29.7 - 46.1	N (2)
			Sr-90	pCi/L	16.6	20.1	14.4 - 23.8	A
			Ba-133	pCi/L	85.2	84.8	71.3 - 93.3	A
			Cs-134	pCi/L	76.9	76.6	62.6 - 84.3	A
			Cs-137	pCi/L	177	183	165 - 203	A
			Co-60	pCi/L	77.4	78.3	70.5 - 88.5	A
			Zn-65	pCi/L	209	204	184 - 240	A
			Gr-A	pCi/L	50.6	58.6	30.6 - 72.9	A
			Gr-B	pCi/L	59.3	39.2	26.0 - 46.7	N (2)
			I-131	pCi/L	22.9	24.8	20.6 - 29.4	A
			H-3	pCi/L	5020	4890	4190 - 5380	A
	MRAD-17	Filter	Gr-A	pCi/filter	59.6	87.5	29.3 - 136	A

(1) Detector G1 is slightly biased high for Th-230 based measurements used only for ERA Gross Alpha samples. NCR 12-05

(2) The Sr-89 found to known ratio was 1.19, which TBE considers acceptable. It appears the aliquot was entered incorrectly for the Gross Beta NCR 12-13

(a) Teledyne Brown Engineering reported result.

(b) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

**TABLE D-3 DOE'S MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 1 OF 2)

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
March 2012	12-MaW26	Water	Cs-134	Bq/L	-0.0045		(1)	A
			Cs-137	Bq/L	37.5	39.9	27.9 - 51.9	A
			Co-57	Bq/L	30.8	32.9	23.0 - 42.8	A
			Co-60	Bq/L	22.4	23.72	16.60 - 30.84	A
			H-3	Bq/L	456	437	306 - 568	A
			Mn-54	Bq/L	31.0	31.8	22.3 - 41.3	A
			K-40	Bq/L	144	142	99 - 185	A
			Sr-90	Bq/L	-0.0084		(1)	A
			Zn-65	Bq/L	-0.369		(1)	A
	12-GrW26	Water	Gr-A	Bq/L	2.06	2.14	0.64 - 3.64	A
			Gr-B	Bq/L	7.48	6.36	3.18 - 9.54	A
	12-MaS26	Soil	Cs-134	Bq/kg	831	828	580 - 1076	A
			Cs-137	Bq/kg	0.145		(1)	A
			Co-57	Bq/kg	1270	1179	825 - 1533	A
			Co-60	Bq/kg	7.61	1.56	(2)	N (3)
			Mn-54	Bq/kg	634	558	391 - 725	A
			K-40	Bq/kg	1690	1491	1044 - 1938	A
			Sr-90	Bq/kg	328	392	274 - 540	A
			Zn-65	Bq/kg	753	642	449 - 835	A
	12-RdF26	AP	Cs-134	Bq/sample	2.31	2.38	1.67 - 3.09	A
			Cs-137	Bq/sample	2.15	1.79	1.25 - 2.33	W
			Co-57	Bq/sample	-0.0701		(1)	A
			Co-60	Bq/sample	2.62	2.182	1.527 - 2.837	W
			Mn-54	Bq/sample	4.13	3.24	2.27 - 4.21	W
			Sr-90	Bq/sample	0.0185		(1)	A
			Zn-65	Bq/sample	4.19	2.99	2.09 - 3.89	N (3)
	12-GrF26	AP	Gr-A	Bq/sample	0.365	1.2	0.4 - 2.0	A
			Gr-B	Bq/sample	2.31	2.4	1.2 - 3.6	A
	12-RdV26	Vegetation	Cs-134	Bq/sample	8.72	8.43	5.90 - 10.96	A
			Cs-137	Bq/sample	0.0424		(1)	A
			Co-57	Bq/sample	15.5	12.0	8.4 - 15.6	W
			Co-60	Bq/sample	6.80	6.05	4.24 - 7.87	A
			Mn-54	Bq/sample	0.0057		(1)	A
			Sr-90	Bq/sample	2.24	2.11	1.48 - 2.74	A
			Zn-65	Bq/sample	10.5	8.90	6.23 - 11.57	A
September 2012	12-MaW27	Water	Cs-134	Bq/L	21.4	23.2	16.2 - 30.2	A
			Cs-137	Bq/L	17.0	16.7	11.7 - 21.7	A
			Co-57	Bq/L	28.7	29.3	20.5 - 38.1	A
			Co-60	Bq/L	0.179		(1)	A
			H-3	Bq/L	387	334	234 - 434	A
			Mn-54	Bq/L	18.1	17.8	12.5 - 23.1	A
			K-40	Bq/L	139	134	94 - 174	A
			Sr-90	Bq/L	19.6	12.2	8.5 - 15.9	N (4)
			Zn-65	Bq/L	27.2	25.9	18.1 - 33.7	A
	12-GrW27	Water	Gr-A	Bq/L	0.966	1.79	0.54 - 3.04	A
			Gr-B	Bq/L	10.0	9.1	4.6 - 13.7	A

**TABLE D-3**                      **DOE'S MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**  
**TELEDYNE BROWN ENGINEERING, 2012**  
(PAGE 2 OF 2)

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
September 2012	12-MaS27	Soil	Cs-134	Bq/kg	880	939	657 - 1221	A
			Cs-137	Bq/kg	1220	1150	805 - 1495	A
			Co-57	Bq/kg	1330	1316	921 - 1711	A
			Co-60	Bq/kg	552	531	372 - 690	A
			Mn-54	Bq/kg	1000	920	644 - 1196	A
			K-40	Bq/kg	674	632	442 - 822	A
			Sr-90	Bq/kg	528	508	356 - 660	A
			Zn-65	Bq/kg	665	606	424 - 788	A
	12-RdF27	AP	Cs-134	Bq/sample	2.760	2.74	1.92 - 3.56	A
			Cs-137	Bq/sample	0.0415		(1)	A
			Co-57	Bq/sample	2.00	191.00	1.34 - 2.48	A
			Co-60	Bq/sample	1.78	1.728	1.210 - 2.246	A
			Mn-54	Bq/sample	2.40	2.36	1.65 - 3.07	A
			Sr-90	Bq/sample	0.931	1.03	0.72 - 1.34	A
			Zn-65	Bq/sample	-0.688		(1)	A
	12-GrF27	AP	Gr-A	Bq/sample	0.434	0.97	0.29 - 1.65	A
			Gr-B	Bq/sample	1.927	1.92	0.96 - 2.88	A
	12-RdV27	Vegetation	Cs-134	Bq/sample	6.28	6.51	4.56 - 8.46	A
			Cs-137	Bq/sample	4.62	4.38	3.07 - 5.69	A
			Co-57	Bq/sample	6.51	5.66	3.96 - 7.36	A
			Co-60	Bq/sample	5.32	5.12	3.58 - 6.66	A
			Mn-54	Bq/sample	3.59	3.27	2.29 - 4.25	A
			Sr-90	Bq/sample	0.0012		(1)	A
			Zn-65	Bq/sample	-0.046		(1)	A

(1) False positive test.

(2) Sensitivity evaluation

(3) No cause was found for the failed high soil Co-60 sensitivity test or the high Zn-65 in AP, which TBE considers an anomaly. NCR 12-08

(4) Sr-90 in water high due to incorrect aliquot entered in LIMS. 12-11

(a) Teledyne Brown Engineering reported result.

(b) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.

TABLE D-4

ERA (a) STATISTICAL SUMMARY PROFICIENCY TESTING PROGRAM<sup>a</sup>  
ENVIRONMENTAL, INC., 2012

(Page 1 of 1)

Lab Code	Date	Analysis	Concentration (pCi/L)		Control Limits	Acceptance
			Laboratory Result <sup>b</sup>	ERA Result <sup>c</sup>		
ERW-1783	04/09/12	Sr-89	62.2 ± 6.0	58.5	46.9 - 66.3	Pass
ERW-1783	04/09/12	Sr-90	33.7 ± 2.1	37.4	27.4 - 43.1	Pass
ERW-1786	04/09/12	Ba-133	75.7 ± 4.1	82.3	69.1 - 90.5	Pass
ERW-1786	04/09/12	Co-60	71.9 ± 4.0	72.9	65.6 - 82.6	Pass
ERW-1786	04/09/12	Cs-134	70.0 ± 4.3	74.2	60.6 - 81.6	Pass
ERW-1786	04/09/12	Cs-137	151.5 ± 6.1	155.0	140.0 - 172.0	Pass
ERW-1786	04/09/12	Zn-65	108.3 ± 89.0	105.0	94.5 - 125.0	Pass
ERW-1789	04/09/12	Gr. Alpha	55.0 ± 2.4	62.9	33.0 - 78.0	Pass
ERW-1789 <sup>d</sup>	04/09/12	Gr. Beta	76.2 ± 1.8	44.2	29.6 - 51.5	Fail
ERW-1798	04/09/12	H-3	16023 ± 355	15800	13800 - 17400	Pass
ERW-6283	10/05/12	Sr-89	41.5 ± 4.1	39.1	29.7 - 46.1	Pass
ERW-6283	10/05/12	Sr-90	19.7 ± 1.6	20.1	14.4 - 23.8	Pass
ERW-6286	10/05/12	Ba-133	82.7 ± 4.4	84.8	71.3 - 93.3	Pass
ERW-6286	10/05/12	Co-60	77.2 ± 3.7	78.3	70.5 - 88.5	Pass
ERW-6286	10/05/12	Cs-134	74.4 ± 1.5	76.6	62.6 - 84.3	Pass
ERW-6286	10/05/12	Cs-137	183.0 ± 6.2	183.0	165.0 - 203.0	Pass
ERW-6286	10/05/12	Zn-65	211.0 ± 9.9	204.0	184.0 - 240.0	Pass
ERW-6288	10/05/12	Gr. Alpha	47.0 ± 2.3	58.6	30.6 - 72.9	Pass
ERW-6288	10/05/12	Gr. Beta	33.4 ± 1.2	39.2	26.0 - 46.7	Pass
ERW-6290	10/05/12	I-131	23.3 ± 1.0	24.8	20.6 - 29.4	Pass

<sup>a</sup> Results obtained by Environmental, Inc., Midwest Laboratory as a participant in the crosscheck program for proficiency testing in drinking water conducted by Environmental Resources Associates (ERA).

<sup>b</sup> Unless otherwise indicated, the laboratory result is given as the mean ± standard deviation for three determinations.

<sup>c</sup> Results are presented as the known values, expected laboratory precision (1 sigma, 1 determination) and control limits as provided by ERA.

<sup>d</sup> Result of reanalysis: 38.3 ± 1.3 pCi/L. Sample dilution problem suspected. A new dilution was prepared.

**TABLE D-5 DOE'S MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**  
**ENVIRONMENTAL, INC., 2012**  
(Page 1 of 2)

Lab Code <sup>b</sup>	Date	Analysis	Laboratory result	Concentration <sup>a</sup>		Acceptance
				Known Activity	Control Limits <sup>c</sup>	
STSO-1766	02/01/12	Co-57	1352.10 ± 4.00	1179.00	825.00 - 1533.00	Pass
STSO-1766	02/01/12	Co-60	1.70 ± 0.70	1.56	1.00 - 2.00	Pass
STSO-1766	02/01/12	Cs-134	842.20 ± 4.30	828.00	580.00 - 1076.00	Pass
STSO-1766	02/01/12	Cs-137	0.40 ± 0.90	0.00	0.00 - 1.00	Pass
STSO-1766	02/01/12	K-40	1729.60 ± 22.20	1491.00	1044.00 - 1938.00	Pass
STSO-1766	02/01/12	Mn-54	647.60 ± 4.20	558.00	391.00 - 725.00	Pass
STSO-1766	02/01/12	Sr-90	383.20 ± 15.30	392.00	274.00 - 510.00	Pass
STSO-1766	02/01/12	Zn-65	766.70 ± 6.70	642.00	449.00 - 835.00	Pass
STAP-1772	02/01/12	Co-57	0.010 ± 0.01	0.00	0.000 - 1.00	Pass
STAP-1772	02/01/12	Co-60	2.40 ± 0.08	2.18	1.53 - 2.84	Pass
STAP-1772	02/01/12	Cs-134	2.33 ± 0.13	2.38	1.67 - 3.09	Pass
STAP-1772	02/01/12	Cs-137	2.07 ± 0.10	1.79	1.25 - 2.33	Pass
STAP-1772	02/01/12	Mn-54	3.77 ± 0.14	3.24	2.27 - 4.21	Pass
STAP-1772	02/01/12	Sr-90	-0.010 ± 0.060	0.000	-0.10 - 0.13	Pass
STAP-1772	02/01/12	Zn-65	3.67 ± 0.20	2.99	2.09 - 3.89	Pass
STAP-1773	02/01/12	Gr. Alpha	0.51 ± 0.05	1.20	0.40 - 2.00	Pass
STAP-1773	02/01/12	Gr. Beta	2.75 ± 0.10	2.40	1.20 - 3.60	Pass
STVE-1776	02/01/12	Co-57	14.57 ± 0.28	12.00	8.40 - 15.60	Pass
STVE-1776	02/01/12	Co-60	6.45 ± 0.23	6.05	4.24 - 7.87	Pass
STVE-1776	02/01/12	Cs-134	8.39 ± 0.29	8.43	5.90 - 10.96	Pass
STVE-1776	02/01/12	Cs-137	0.01 ± 0.09	0.00	0.00 - 0.10	Pass
STVE-1776	02/01/12	Mn-54	0.03 ± 0.08	0.00	0.00 - 0.10	Pass
STVE-1776	02/01/12	Zn-65	10.31 ± 0.67	8.90	6.23 - 11.57	Pass
STW-1960	02/01/12	Gr. Alpha	1.68 ± 0.09	2.14	0.64 - 3.64	Pass
STW-1960	02/01/12	Gr. Beta	6.33 ± 0.10	6.36	3.18 - 9.54	Pass
STW-1964	02/01/12	Co-57	33.30 ± 0.40	32.90	23.00 - 42.80	Pass
STW-1964	02/01/12	Co-60	23.20 ± 0.40	23.72	16.60 - 30.84	Pass
STW-1964	02/01/12	Cs-134	0.30 ± 3.00	0.00	0.00 - 1.00	Pass
STW-1964	02/01/12	Cs-137	40.10 ± 0.60	39.90	27.90 - 51.90	Pass
STW-1964	02/01/12	H-3	460.00 ± 12.10	437.00	306.00 - 568.00	Pass
STW-1964	02/01/12	K-40	153.00 ± 4.20	142.00	99.00 - 185.00	Pass
STW-1964	02/01/12	Mn-54	32.70 ± 0.60	31.80	22.30 - 41.30	Pass
STW-1964	02/01/12	Sr-90	0.10 ± 0.20	0.00	0.00 - 1.00	Pass
STW-1964	02/01/12	Zn-65	0.01 ± 0.20	0.00	0.00 - 1.00	Pass



**TABLE D-5 DOE'S MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)**  
**ENVIRONMENTAL, INC., 2012**  
(Page 2 of 2)

Lab Code <sup>b</sup>	Date	Analysis	Laboratory result	Concentration <sup>a</sup>		Acceptance
				Known Activity	Control Limits <sup>c</sup>	
STSO-5392	08/01/12	Sr-90	483.52 ± 16.47	508.00	356.00 - 660.00	Pass
STSO-5394	08/01/12	Co-57	1528.00 ± 4.10	1316.00	921.00 - 1711.00	Pass
STSO-5394	08/01/12	Co-60	592.00 ± 3.20	531.00	372.00 - 690.00	Pass
STSO-5394	08/01/12	Cs-134	933.60 ± 5.82	939.00	657.00 - 1221.00	Pass
STSO-5394	08/01/12	Cs-137	1319.80 ± 5.50	1150.00	805.00 - 1495.00	Pass
STSO-5394	08/01/12	K-40	737.30 ± 17.70	632.00	442.00 - 822.00	Pass
STSO-5394	08/01/12	Mn-54	1083.20 ± 5.20	920.00	644.00 - 1196.00	Pass
STSO-5394	08/01/12	Zn-65	696.10 ± 7.00	606.00	424.00 - 788.00	Pass
STVE-5395 d	08/01/12	Co-57	7.44 ± 0.17	5.66	3.96 - 7.36	Fail
STVE-5395	08/01/12	Co-60	5.90 ± 0.15	5.12	3.58 - 6.66	Pass
STVE-5395	08/01/12	Cs-134	7.40 ± 0.31	6.51	4.56 - 8.46	Pass
STVE-5395	08/01/12	Cs-137	5.45 ± 0.18	4.38	3.07 - 5.69	Pass
STVE-5395	08/01/12	Mn-54	4.06 ± 0.21	3.27	2.29 - 4.25	Pass
STAP-5398	08/01/12	Gr. Alpha	0.41 ± 0.05	0.97	0.29 - 1.65	Pass
STAP-5398	08/01/12	Gr. Beta	2.11 ± 0.09	1.92	0.96 - 2.88	Pass
STAP-5403	08/01/12	Co-57	1.96 ± 0.05	1.91	1.34 - 2.48	Pass
STAP-5403	08/01/12	Co-60	1.76 ± 0.07	1.73	1.21 - 2.25	Pass
STAP-5403	08/01/12	Cs-134	2.74 ± 0.18	2.74	1.92 - 3.56	Pass
STAP-5403	08/01/12	Cs-137	0.00 ± 0.03	0.00	-0.01 - 0.01	Pass
STAP-5403	08/01/12	Mn-54	2.52 ± 0.10	2.36	1.65 - 3.07	Pass
STAP-5403	08/01/12	Zn-65	0.01 ± 0.06	0.00	-0.010 - 0.010	Pass

<sup>a</sup> Results are reported in units of Bq/kg (soil), Bq/L (water) or Bq/total sample (filters, vegetation).

<sup>b</sup> Laboratory codes as follows: STW (water), STAP (air filter), STSO (soil), STVE (vegetation).

<sup>c</sup> MAPEP results are presented as the known values and expected laboratory precision (1 sigma, 1 determination) and control limits as defined by the MAPEP. A known value of "zero" indicates an analysis was included in the testing series as a "false positive". MAPEP does not provide control limits.

<sup>d</sup> Result of recount; 6.74 ± 0.15 Bq/sample. Gamma emitters for the vegetation matrix exhibited a high bias, only Co-57 exceeded acceptance limits. Recounted using a geometry more closely matched to the MAPEP sample size.

# **APPENDIX E**

## **EFFLUENT DATA**

## **APPENDIX E-1**

### **DATA TABLES AND FIGURES**

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## INTRODUCTION

Units 1 and 2 of the Zion Station, located in Zion, Illinois adjacent to Lake Michigan, are 1100 MWe (3520 MWt) Westinghouse pressurized water reactors. The plant permanently ceased operation in February of 1998 and has been permanently defueled.

The station was designed to keep releases to the environment at levels below those specified in the regulations. Historical data has been established that Zion, as a fully operational facility, did not contribute appreciable doses to the surrounding public. Sampling results for 2012 showed minimal releases above background for a variety of monitored pathways, e.g. water, vegetation, air samples and TLIV.

Liquid effluents from Zion Station are released to Lake Michigan in controlled batches after radioassay of each batch and continuously through a monitored pathway. There are no routine noble gas releases. Due to decay, iodine is no longer present. The only noble gas that remains is Kr85 captured in the spent fuel assemblies stored in the fuel pool in the fuel building. The results of effluent analyses are summarized on a monthly basis and reported to the Nuclear Regulatory Commission as required per Technical Specifications. Airborne concentrations of noble gases and particulate radioactivity in offsite areas are calculated using effluent and meteorological data.

Currently Zion Station is undergoing decommissioning. During the decommissioning process, containerized waste will be temporarily maintained at designated locations onsite. The designated locations are located in a manner to minimize the direct radiation exposure to the public at or near the site boundary.

Environmental monitoring was conducted by sampling at indicator and control (background) locations in the vicinity of the Zion Station to measure changes in radiation or radioactivity levels that may be attributable to the station. If significant changes attributable to Zion Station are measured, these changes are correlated with effluent releases or direct radiation from containerized waste.

## SUMMARY

Gaseous, liquid and solid waste effluents for the period contributed to only a small fraction of the Station Technical Specification limits. Calculations of environmental concentrations based on effluent and meteorological data for the period indicate that consumption by the public of radionuclides attributable to the Zion Station does not exceed regulatory limits. Radiation exposure from direct radiation from containerized waste at the site boundary represented the critical pathway for the period with a maximum individual total body dose estimated to be  $2.75\text{E}+00$  mrem for the year, where a shielding and occupancy factor of  $1.37\text{E}-01$  is assumed. The assessment of radiation doses is performed in accordance with the Zion Station Offsite Dose Calculation Manual (ODCM). The results of analysis confirm that the station is operating in compliance with 10CFR50 Appendix 1, 10CFR20 and 40CFR190.

## 1.0 EFFLUENTS

### 1.1 Gaseous Effluents to the Atmosphere

Measured concentrations and isotopic composition of noble gases and particulate radioactivity released to the atmosphere were monitored during the year. A total of 0.00E+00 microcuries of fission and activation gases was released with a maximum average release rate of 0.00E+00  $\mu\text{Ci/sec}$  during any one quarter period.

A total of 0.00E+00 microcuries of beta-gamma emitters was released as airborne particulate matter with a maximum average quarterly release rate of 0.00E-06  $\mu\text{Ci/sec}$ . Alpha-emitting radionuclides were not measurable. Also, 4.92E-02 curies of tritium were released with a maximum average quarterly release rate of 1.81E-03  $\mu\text{Ci/sec}$ .

### 1.2 Liquids Released to Lake Michigan

A total of 1.23E+07 liters of liquid waste containing 0.00E+00 microcuries was discharged from the station via an approved pathway after dilution with a total of 1.71E+10 liters of water. These wastes were released at a maximum quarterly average concentration of 0.00E+00  $\mu\text{Ci/ml}$ . A total of 0.00E-00 curies of tritium was released. Alpha activity released totaled 0.00  $\mu\text{Ci}$  for the year. Monthly release estimates and principal radionuclides in liquid effluents are reported in the Zion Nuclear Power Station Radioactive Effluent Report for 2012.

## 2.0 SOLID RADIOACTIVE WASTE

There were 79 solid radioactive waste shipments in 2012. For more detail, refer to the Zion Station 2012 Annual radioactive Effluent Release Report.

## 3.0 DOSE TO MAN

### 3.1 Gaseous Effluent Pathways

Table 3.1-1 summarizes the doses resulting from releases of airborne radioactivity via the different exposure pathways.



### 3.1.1 Gaseous Releases

#### 3.1.1.1 Gamma Dose Rates

Offsite Gamma air and whole (total) body dose rates are shown in Table 3.1-1 and were calculated based on measured release rates, isotopic composition of the gases, and meteorological data for the period. Based on measured effluents and average meteorological data, the maximum total body dose to an individual would be 1.25 E-04 mrem (child) for the year (Table 3.1-1), with an occupancy or shielding factor of 0.7 included, and based on measured effluents and concurrent meteorological data would be 6.80E-05 mrem (Table 3.5-1). The maximum gamma air dose was 0.00E+00 mrad based on measured effluents and average meteorological data (Table 3.1-1), and 0.00E+00 mrad based on measured effluents and concurrent meteorological data (Table 3.5-1).

#### 3.1.1.2 Beta Air and Skin Dose Rates

The range of beta particles in air is relatively small (on the order of a few meters or less); consequently, plumes of gaseous effluents may be considered "infinite" for purpose of calculating the dose from beta radiation incident on the skin. However, the actual dose to sensitive skin tissues is difficult to calculate due to the effect of the beta particle energies, thickness of inert skin and clothing covering sensitive tissues. For purposes of this report the skin is taken to have a thickness of 7.0 mg/cm<sup>2</sup> and an occupancy factor of 1.0 is used. The skin dose from beta and gamma radiation for the year was 0.00E+00 mrem based on measured effluents and average meteorological data (Table 3.1-1), and 0.00E+00 mrem based on measured effluents and concurrent meteorological data (Table 3.5-1).

The maximum offsite beta air dose for the year was 0.00E+00 mrad based on measured effluents

and average meteorological data (Table 3.1-1), and 0.00E+00 mrad based on measured effluents and concurrent meteorological data (Table 3.5-1).

#### 3.1.2 Radioactive Iodine

The human thyroid exhibits a significant capacity to concentrate ingested or inhaled iodine. The radioiodine, I-131, released during routine operation of the station, may be made available to man resulting in a dose to the thyroid. The principal pathway of interest for this radionuclide is ingestion of radioiodine in milk. As Zion Station is not operational and I-131 has decayed away, the maximum offsite concentration is estimated to be zero, as expected.

#### 3.1.3 Dose to Thyroid

The hypothetical thyroid dose to a maximum exposed individual living near the station via ingestion of milk was calculated. As Zion Station is not operational and I-131 has decayed away, the maximum offsite concentration is estimated to be zero, as expected.

### 3.2 Liquid Effluent Pathways

The three principal pathways through the aquatic environment for potential doses to man from liquid waste are ingestion of potable water, eating aquatic foods, and exposure while on the shoreline. Not all of these pathways are significant or applicable at a given time but a reasonable approximation of the dose can be made by adjusting the dose formula for season of the year or type and degree of use of the aquatic environment. NRC developed equations\* were used to calculate the doses to the whole body, lower GI tracts, thyroid, bone, skin; specific parameters for use in the equations are given in the Zion Station Offsite Dose Calculation Manual. The maximum whole body dose (total body) for the year was 0.00E+00 mrem and no organ dose exceeded 0.00E+00 mrem (Table 3.2-1).

### 3.3 Direct Radiation

During the period January to December 2012, Zion Station during decommissioning has stored containerized radioactive waste that contributed a total of 2.75E+00 mrem to the whole body of a maximally exposed individual at site boundary taking into account

the occupancy factor of 1.37E-01 calculated in Zion Station  
Technical Support Document 13 (TSD 13-002)

### 3.4 Assessment of Dose to Member of Public

During the period January to December, 2012, Zion Station did not exceed the below limits as shown in Table 3.1-1 and Table 3.2-1 (based on yearly average meteorological data), and Figure 3.1-1 (based on concurrent meteorological data):

- The RETS limits on dose or dose commitment to an individual due to radioactive materials in liquid effluents from each reactor unit (3 mrem to the whole body or 10 mrem to any organ during any calendar year).
- The RETS limits on air dose in noble gases released in gaseous effluents to a member of the public from each reactor unit (10 mrad for gamma radiation or 20 mrad for beta radiation during any calendar year).
- The RETS limits on dose to a member of the public due to iodine-131, iodine-133, tritium, and radionuclides in particulate form with half-lives greater than eight days in gaseous effluents released from each reactor unit (15 mrem to any organ during any calendar year).
- The 10CFR20 limit on Total Effective Dose Equivalent to individual members of the public (100 mrem).

### 4.0 SITE METEOROLOGY

A summary of the site meteorological measurements taken during each calendar quarter of the year is given in Appendix F. The data are presented as cumulative joint frequency

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\*Nuclear Regulatory Commission, Regulatory Guide 1.109 (Rev. 1)  
distributions of the wind direction for the 250' level and wind speed class by atmospheric stability class determined from the temperature difference between the 250' and 35' levels. Data recovery for these measurements was 99.6% during 2012 (Table 3.5-1).

**Table 2.0-1**  
**Solid Radioactive Waste**

Table 2.0-1 has been deliberately deleted. For details on solid waste disposal, see the Zion 2012 Annual Effluent Report

**Table 3.1-1**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 04/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical

=== RELEASE DATA ===  
Total Release Duration (minutes)..... 5.242E+05  
Total Release Volume (cf)..... 1.521E+10  
Average Release Flowrate (cfm)..... 2.902E+04  
  
Average Period Flowrate (cfm)..... 1.161E+05

=== NUCLIDE DATA ===

Nuclide	uCi	Average uCi/cc	ECrcent Ratio	EC
H-3	1.32E+04	3.06E-11	3.06E-04	1.00E-07
H-3	1.32E+04	3.06E-11	3.06E-04	
Total	1.32E+04	3.06E-11	3.06E-04	

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 04/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

```

=== PERIOD DOSE BY AGEGROUP, PATHWAY, ORGAN (mrem) =====
Age/Path Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
AINHL      0.00E+00  4.16E-06  4.16E-06  4.16E-06  4.16E-06  4.16E-06  0.00E+00  4.16E-06
AVEG       0.00E+00  7.47E-06  7.47E-06  7.47E-06  7.47E-06  7.47E-06  0.00E+00  7.47E-06
AGMILK     0.00E+00  5.14E-06  5.14E-06  5.14E-06  5.14E-06  5.14E-06  0.00E+00  5.14E-06
ACMEAT     0.00E+00  1.07E-06  1.07E-06  1.07E-06  1.07E-06  1.07E-06  0.00E+00  1.07E-06
ACMILK     0.00E+00  2.52E-06  2.52E-06  2.52E-06  2.52E-06  2.52E-06  0.00E+00  2.52E-06
TINHL      0.00E+00  4.20E-06  4.20E-06  4.20E-06  4.20E-06  4.20E-06  0.00E+00  4.20E-06
TVEG       0.00E+00  8.54E-06  8.54E-06  8.54E-06  8.54E-06  8.54E-06  0.00E+00  8.54E-06
TGMILK     0.00E+00  6.69E-06  6.69E-06  6.69E-06  6.69E-06  6.69E-06  0.00E+00  6.69E-06
TCMEAT     0.00E+00  6.39E-07  6.39E-07  6.39E-07  6.39E-07  6.39E-07  0.00E+00  6.39E-07
TCMILK     0.00E+00  3.28E-06  3.28E-06  3.28E-06  3.28E-06  3.28E-06  0.00E+00  3.28E-06
CINHL      0.00E+00  3.71E-06  3.71E-06  3.71E-06  3.71E-06  3.71E-06  0.00E+00  3.71E-06
CVEG       0.00E+00  1.33E-05  1.33E-05  1.33E-05  1.33E-05  1.33E-05  0.00E+00  1.33E-05
CGMILK     0.00E+00  1.06E-05  1.06E-05  1.06E-05  1.06E-05  1.06E-05  0.00E+00  1.06E-05
CCMEAT     0.00E+00  7.75E-07  7.75E-07  7.75E-07  7.75E-07  7.75E-07  0.00E+00  7.75E-07
CCMILK     0.00E+00  5.20E-06  5.20E-06  5.20E-06  5.20E-06  5.20E-06  0.00E+00  5.20E-06
IINHL      0.00E+00  2.13E-06  2.13E-06  2.13E-06  2.13E-06  2.13E-06  0.00E+00  2.13E-06
IGMILK     0.00E+00  1.61E-05  1.61E-05  1.61E-05  1.61E-05  1.61E-05  0.00E+00  1.61E-05
ICMILK     0.00E+00  7.88E-06  7.88E-06  7.88E-06  7.88E-06  7.88E-06  0.00E+00  7.88E-06

```

```

=== PERIOD DOSE BY AGEGROUP, ORGAN (mrem) =====
Agegroup Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
ADULT      0.00E+00  2.04E-05  2.04E-05  2.04E-05  2.04E-05  2.04E-05  0.00E+00  2.04E-05
TEEN       0.00E+00  2.34E-05  2.34E-05  2.34E-05  2.34E-05  2.34E-05  0.00E+00  2.34E-05
CHILD      0.00E+00  3.35E-05  3.35E-05  3.35E-05  3.35E-05  3.35E-05  0.00E+00  3.35E-05
INFANT     0.00E+00  2.61E-05  2.61E-05  2.61E-05  2.61E-05  2.61E-05  0.00E+00  2.61E-05

```

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 04/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

=== MAXIMUM PERIOD DOSE TO LIMIT (Any Organ) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	LIVER	3.35E-05	31-day	2.25E-01	1.49E-02	3.00E-01	1.12E-02
				Quarter	5.63E+00	5.96E-04	7.50E+00	4.47E-04
				Annual	1.13E+01	2.98E-04	1.50E+01	2.24E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	9.99E+01

=== MAXIMUM PERIOD DOSE TO LIMIT (Tot Body) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	TBODY	3.35E-05	31-day	1.50E-01	2.24E-02	2.00E-01	1.68E-02
				Quarter	5.25E+00	6.39E-04	7.50E+00	4.47E-04
				Annual	1.05E+01	3.19E-04	1.50E+01	2.24E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	9.99E+01

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 04/01/2012 00:00  
Period End Date.....: 07/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical

=== RELEASE DATA ===  
Total Release Duration (minutes)..... 5.136E+05  
Total Release Volume (cf)..... 1.547E+10  
Average Release Flowrate (cfm)..... 3.013E+04  
  
Average Period Flowrate (cfm)..... 1.181E+05

=== NUCLIDE DATA ===

Nuclide	uCi	Average uCi/cc	ECrcent Ratio	EC
H-3	1.42E+04	3.25E-11	3.25E-04	1.00E-07
H-3	1.42E+04	3.25E-11	3.25E-04	
Total	1.42E+04	3.25E-11	3.25E-04	



**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 04/01/2012 00:00  
Period End Date.....: 07/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

```

=== PERIOD DOSE BY AGEGROUP, PATHWAY, ORGAN (mrem) ===
Age/Path Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
AINHL      0.00E+00  4.49E-06  4.49E-06  4.49E-06  4.49E-06  4.49E-06  0.00E+00  4.49E-06
AVEG       0.00E+00  8.05E-06  8.05E-06  8.05E-06  8.05E-06  8.05E-06  0.00E+00  8.05E-06
AGMILK     0.00E+00  5.55E-06  5.55E-06  5.55E-06  5.55E-06  5.55E-06  0.00E+00  5.55E-06
ACMEAT     0.00E+00  1.16E-06  1.16E-06  1.16E-06  1.16E-06  1.16E-06  0.00E+00  1.16E-06
ACMILK     0.00E+00  2.72E-06  2.72E-06  2.72E-06  2.72E-06  2.72E-06  0.00E+00  2.72E-06
TINHL      0.00E+00  4.53E-06  4.53E-06  4.53E-06  4.53E-06  4.53E-06  0.00E+00  4.53E-06
TVEG       0.00E+00  9.22E-06  9.22E-06  9.22E-06  9.22E-06  9.22E-06  0.00E+00  9.22E-06
TGMILK     0.00E+00  7.22E-06  7.22E-06  7.22E-06  7.22E-06  7.22E-06  0.00E+00  7.22E-06
TCMEAT     0.00E+00  6.90E-07  6.90E-07  6.90E-07  6.90E-07  6.90E-07  0.00E+00  6.90E-07
TCMILK     0.00E+00  3.54E-06  3.54E-06  3.54E-06  3.54E-06  3.54E-06  0.00E+00  3.54E-06
CINHL      0.00E+00  4.00E-06  4.00E-06  4.00E-06  4.00E-06  4.00E-06  0.00E+00  4.00E-06
CVEG       0.00E+00  1.43E-05  1.43E-05  1.43E-05  1.43E-05  1.43E-05  0.00E+00  1.43E-05
CGMILK     0.00E+00  1.14E-05  1.14E-05  1.14E-05  1.14E-05  1.14E-05  0.00E+00  1.14E-05
CCMEAT     0.00E+00  8.36E-07  8.36E-07  8.36E-07  8.36E-07  8.36E-07  0.00E+00  8.36E-07
CCMILK     0.00E+00  5.61E-06  5.61E-06  5.61E-06  5.61E-06  5.61E-06  0.00E+00  5.61E-06
IINHL      0.00E+00  2.30E-06  2.30E-06  2.30E-06  2.30E-06  2.30E-06  0.00E+00  2.30E-06
IGMILK     0.00E+00  1.74E-05  1.74E-05  1.74E-05  1.74E-05  1.74E-05  0.00E+00  1.74E-05
ICMILK     0.00E+00  8.50E-06  8.50E-06  8.50E-06  8.50E-06  8.50E-06  0.00E+00  8.50E-06

```

```

=== PERIOD DOSE BY AGEGROUP, ORGAN (mrem) ===
Agegroup Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
ADULT      0.00E+00  2.20E-05  2.20E-05  2.20E-05  2.20E-05  2.20E-05  0.00E+00  2.20E-05
TEEN       0.00E+00  2.52E-05  2.52E-05  2.52E-05  2.52E-05  2.52E-05  0.00E+00  2.52E-05
CHILD      0.00E+00  3.62E-05  3.62E-05  3.62E-05  3.62E-05  3.62E-05  0.00E+00  3.62E-05
INFANT     0.00E+00  2.82E-05  2.82E-05  2.82E-05  2.82E-05  2.82E-05  0.00E+00  2.82E-05

```

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 04/01/2012 00:00  
Period End Date.....: 07/01/2012 00:00  
Period Duration (min): 1.310E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

=== MAXIMUM PERIOD DOSE TO LIMIT (Any Organ) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	LIVER	3.62E-05	31-day	2.25E-01	1.61E-02	3.00E-01	1.21E-02
				Quarter	5.63E+00	6.43E-04	7.50E+00	4.82E-04
				Annual	1.13E+01	3.22E-04	1.50E+01	2.41E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            1.00E+02

=== MAXIMUM PERIOD DOSE TO LIMIT (Tot Body) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	TBODY	3.62E-05	31-day	1.50E-01	2.41E-02	2.00E-01	1.81E-02
				Quarter	5.25E+00	6.89E-04	7.50E+00	4.82E-04
				Annual	1.05E+01	3.45E-04	1.50E+01	2.41E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            1.00E+02

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date.....: 07/01/2012 00:00  
Period End Date.....: 10/01/2012 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical

=== RELEASE DATA ===  
Total Release Duration (minutes)..... 5.299E+05  
Total Release Volume (cf)..... 1.722E+10  
Average Release Flowrate (cfm)..... 3.249E+04  
  
Average Period Flowrate (cfm)..... 1.299E+05

=== NUCLIDE DATA ===

Nuclide	uCi	Average uCi/cc	ECrcent Ratio	EC
H-3	9.00E+03	1.85E-11	1.85E-04	1.00E-07
H-3	9.00E+03	1.85E-11	1.85E-04	
Total	9.00E+03	1.85E-11	1.85E-04	

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 07/01/2012 00:00  
Period End Date.....: 10/01/2012 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

```

=== PERIOD DOSE BY AGEGROUP, PATHWAY, ORGAN (mrem) ===
Age/Path Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
AINHL      0.00E+00  2.84E-06  2.84E-06  2.84E-06  2.84E-06  2.84E-06  0.00E+00  2.84E-06
AVEG       0.00E+00  5.10E-06  5.10E-06  5.10E-06  5.10E-06  5.10E-06  0.00E+00  5.10E-06
AGMILK     0.00E+00  3.51E-06  3.51E-06  3.51E-06  3.51E-06  3.51E-06  0.00E+00  3.51E-06
ACMEAT     0.00E+00  7.33E-07  7.33E-07  7.33E-07  7.33E-07  7.33E-07  0.00E+00  7.33E-07
ACMILK     0.00E+00  1.72E-06  1.72E-06  1.72E-06  1.72E-06  1.72E-06  0.00E+00  1.72E-06
TINHL      0.00E+00  2.87E-06  2.87E-06  2.87E-06  2.87E-06  2.87E-06  0.00E+00  2.87E-06
TVEG       0.00E+00  5.83E-06  5.83E-06  5.83E-06  5.83E-06  5.83E-06  0.00E+00  5.83E-06
TGMILK     0.00E+00  4.57E-06  4.57E-06  4.57E-06  4.57E-06  4.57E-06  0.00E+00  4.57E-06
TCMEAT     0.00E+00  4.36E-07  4.36E-07  4.36E-07  4.36E-07  4.36E-07  0.00E+00  4.36E-07
TCMILK     0.00E+00  2.24E-06  2.24E-06  2.24E-06  2.24E-06  2.24E-06  0.00E+00  2.24E-06
CINHL      0.00E+00  2.53E-06  2.53E-06  2.53E-06  2.53E-06  2.53E-06  0.00E+00  2.53E-06
CVEG       0.00E+00  9.05E-06  9.05E-06  9.05E-06  9.05E-06  9.05E-06  0.00E+00  9.05E-06
CGMILK     0.00E+00  7.24E-06  7.24E-06  7.24E-06  7.24E-06  7.24E-06  0.00E+00  7.24E-06
CCMEAT     0.00E+00  5.29E-07  5.29E-07  5.29E-07  5.29E-07  5.29E-07  0.00E+00  5.29E-07
CCMILK     0.00E+00  3.55E-06  3.55E-06  3.55E-06  3.55E-06  3.55E-06  0.00E+00  3.55E-06
IINHL      0.00E+00  1.46E-06  1.46E-06  1.46E-06  1.46E-06  1.46E-06  0.00E+00  1.46E-06
IGMILK     0.00E+00  1.10E-05  1.10E-05  1.10E-05  1.10E-05  1.10E-05  0.00E+00  1.10E-05
ICMILK     0.00E+00  5.38E-06  5.38E-06  5.38E-06  5.38E-06  5.38E-06  0.00E+00  5.38E-06

```

```

=== PERIOD DOSE BY AGEGROUP, ORGAN (mrem) ===
Agegroup Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
ADULT      0.00E+00  1.39E-05  1.39E-05  1.39E-05  1.39E-05  1.39E-05  0.00E+00  1.39E-05
TEEN       0.00E+00  1.59E-05  1.59E-05  1.59E-05  1.59E-05  1.59E-05  0.00E+00  1.59E-05
CHILD      0.00E+00  2.29E-05  2.29E-05  2.29E-05  2.29E-05  2.29E-05  0.00E+00  2.29E-05
INFANT     0.00E+00  1.78E-05  1.78E-05  1.78E-05  1.78E-05  1.78E-05  0.00E+00  1.78E-05

```

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 07/01/2012 00:00  
Period End Date.....: 10/01/2012 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

=== MAXIMUM PERIOD DOSE TO LIMIT (Any Organ) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	LIVER	2.29E-05	31-day	2.25E-01	1.02E-02	3.00E-01	7.63E-03
				Quarter	5.63E+00	4.07E-04	7.50E+00	3.05E-04
				Annual	1.13E+01	2.04E-04	1.50E+01	1.53E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	1.00E+02

=== MAXIMUM PERIOD DOSE TO LIMIT (Tot Body) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	TBODY	2.29E-05	31-day	1.50E-01	1.53E-02	2.00E-01	1.14E-02
				Quarter	5.25E+00	4.36E-04	7.50E+00	3.05E-04
				Annual	1.05E+01	2.18E-04	1.50E+01	1.53E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total

Nuclide	Percentage
H-3	1.00E+02

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 10/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical

=== RELEASE DATA ===  
Total Release Duration (minutes)..... 5.299E+05  
Total Release Volume (cf)..... 1.722E+10  
Average Release Flowrate (cfm)..... 3.250E+04

Average Period Flowrate (cfm)..... 1.300E+05

=== NUCLIDE DATA ===

Nuclide	uCi	Average uCi/cc	ECrcent Ratio	EC
H-3	1.28E+04	2.62E-11	2.62E-04	1.00E-07
H-3	1.28E+04	2.62E-11	2.62E-04	
Total	1.28E+04	2.62E-11	2.62E-04	

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date.....: 10/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters).....: 0.0  
Compass Point.....: 0.0

```

=== PERIOD DOSE BY AGEGROUP, PATHWAY, ORGAN (mrem) =====
Age/Path Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
AINHL      0.00E+00  4.04E-06  4.04E-06  4.04E-06  4.04E-06  4.04E-06  0.00E+00  4.04E-06
AVEG       0.00E+00  7.25E-06  7.25E-06  7.25E-06  7.25E-06  7.25E-06  0.00E+00  7.25E-06
AGMILK     0.00E+00  4.99E-06  4.99E-06  4.99E-06  4.99E-06  4.99E-06  0.00E+00  4.99E-06
ACMEAT     0.00E+00  1.04E-06  1.04E-06  1.04E-06  1.04E-06  1.04E-06  0.00E+00  1.04E-06
ACMILK     0.00E+00  2.45E-06  2.45E-06  2.45E-06  2.45E-06  2.45E-06  0.00E+00  2.45E-06
TINHL      0.00E+00  4.08E-06  4.08E-06  4.08E-06  4.08E-06  4.08E-06  0.00E+00  4.08E-06
TVEG       0.00E+00  8.30E-06  8.30E-06  8.30E-06  8.30E-06  8.30E-06  0.00E+00  8.30E-06
TGMILK     0.00E+00  6.50E-06  6.50E-06  6.50E-06  6.50E-06  6.50E-06  0.00E+00  6.50E-06
TCMEAT     0.00E+00  6.21E-07  6.21E-07  6.21E-07  6.21E-07  6.21E-07  0.00E+00  6.21E-07
TCMILK     0.00E+00  3.19E-06  3.19E-06  3.19E-06  3.19E-06  3.19E-06  0.00E+00  3.19E-06
CINHL      0.00E+00  3.60E-06  3.60E-06  3.60E-06  3.60E-06  3.60E-06  0.00E+00  3.60E-06
CVEG       0.00E+00  1.29E-05  1.29E-05  1.29E-05  1.29E-05  1.29E-05  0.00E+00  1.29E-05
CGMILK     0.00E+00  1.03E-05  1.03E-05  1.03E-05  1.03E-05  1.03E-05  0.00E+00  1.03E-05
CCMEAT     0.00E+00  7.53E-07  7.53E-07  7.53E-07  7.53E-07  7.53E-07  0.00E+00  7.53E-07
CCMILK     0.00E+00  5.05E-06  5.05E-06  5.05E-06  5.05E-06  5.05E-06  0.00E+00  5.05E-06
IINHL      0.00E+00  2.07E-06  2.07E-06  2.07E-06  2.07E-06  2.07E-06  0.00E+00  2.07E-06
IGMILK     0.00E+00  1.56E-05  1.56E-05  1.56E-05  1.56E-05  1.56E-05  0.00E+00  1.56E-05
ICMILK     0.00E+00  7.65E-06  7.65E-06  7.65E-06  7.65E-06  7.65E-06  0.00E+00  7.65E-06

```

```

=== PERIOD DOSE BY AGEGROUP, ORGAN (mrem) =====
Agegroup Bone      Liver      Thyroid      Kidney      Lung      GI-Lli      Skin      TB
-----
ADULT      0.00E+00  1.98E-05  1.98E-05  1.98E-05  1.98E-05  1.98E-05  0.00E+00  1.98E-05
TEEN       0.00E+00  2.27E-05  2.27E-05  2.27E-05  2.27E-05  2.27E-05  0.00E+00  2.27E-05
CHILD      0.00E+00  3.26E-05  3.26E-05  3.26E-05  3.26E-05  3.26E-05  0.00E+00  3.26E-05
INFANT     0.00E+00  2.53E-05  2.53E-05  2.53E-05  2.53E-05  2.53E-05  0.00E+00  2.53E-05

```

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date.....: 10/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 1.325E+05  
Coefficient Type.....: Historical  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters).....: 0.0  
Compass Point.....: 0.0

=== MAXIMUM PERIOD DOSE TO LIMIT (Any Organ) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	LIVER	3.26E-05	31-day	2.25E-01	1.45E-02	3.00E-01	1.09E-02
				Quarter	5.63E+00	5.79E-04	7.50E+00	4.34E-04
				Annual	1.13E+01	2.90E-04	1.50E+01	2.17E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            1.00E+02

=== MAXIMUM PERIOD DOSE TO LIMIT (Tot Body) ===

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	TBODY	3.26E-05	31-day	1.50E-01	2.17E-02	2.00E-01	1.63E-02
				Quarter	5.25E+00	6.20E-04	7.50E+00	4.34E-04
				Annual	1.05E+01	3.10E-04	1.50E+01	2.17E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            1.00E+02



**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 5.270E+05  
Coefficient Type.....: Historical  
From Unit.....: 0  
To Unit.....: 2

=== RELEASE DATA ===  
Total Release Duration (minutes)..... 2.098E+06  
Total Release Volume (cf)..... 6.513E+10  
Average Release Flowrate (cfm)..... 3.104E+04

Average Period Flowrate (cfm)..... 1.236E+05

=== NUCLIDE DATA ===

Nuclide	uCi	Average uCi/cc	ECrcent Ratio	EC
H-3	4.92E+04	2.67E-11	2.67E-04	1.00E-07
H-3	4.92E+04	2.67E-11	2.67E-04	
Total	4.92E+04	2.67E-11	2.67E-04	

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 5.270E+05  
Coefficient Type.....: Historical  
From Unit.....: 0  
To Unit.....: 2  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

=== PERIOD DOSE BY AGEGROUP, PATHWAY, ORGAN (mrem) ===  
Age/Path Bone Liver Thyroid Kidney Lung GI-Lli Skin TB

AINHL	0.00E+00	1.55E-05	1.55E-05	1.55E-05	1.55E-05	1.55E-05	0.00E+00	1.55E-05
AVEG	0.00E+00	2.79E-05	2.79E-05	2.79E-05	2.79E-05	2.79E-05	0.00E+00	2.79E-05
AGMILK	0.00E+00	1.92E-05	1.92E-05	1.92E-05	1.92E-05	1.92E-05	0.00E+00	1.92E-05
ACMEAT	0.00E+00	4.01E-06	4.01E-06	4.01E-06	4.01E-06	4.01E-06	0.00E+00	4.01E-06
ACMILK	0.00E+00	9.41E-06	9.41E-06	9.41E-06	9.41E-06	9.41E-06	0.00E+00	9.41E-06
TINHL	0.00E+00	1.57E-05	1.57E-05	1.57E-05	1.57E-05	1.57E-05	0.00E+00	1.57E-05
TVEG	0.00E+00	3.19E-05	3.19E-05	3.19E-05	3.19E-05	3.19E-05	0.00E+00	3.19E-05
TGMILK	0.00E+00	2.50E-05	2.50E-05	2.50E-05	2.50E-05	2.50E-05	0.00E+00	2.50E-05
TCMEAT	0.00E+00	2.39E-06	2.39E-06	2.39E-06	2.39E-06	2.39E-06	0.00E+00	2.39E-06
TCMILK	0.00E+00	1.22E-05	1.22E-05	1.22E-05	1.22E-05	1.22E-05	0.00E+00	1.22E-05
CINHL	0.00E+00	1.38E-05	1.38E-05	1.38E-05	1.38E-05	1.38E-05	0.00E+00	1.38E-05
CVEG	0.00E+00	4.95E-05	4.95E-05	4.95E-05	4.95E-05	4.95E-05	0.00E+00	4.95E-05
CGMILK	0.00E+00	3.96E-05	3.96E-05	3.96E-05	3.96E-05	3.96E-05	0.00E+00	3.96E-05
CCMEAT	0.00E+00	2.89E-06	2.89E-06	2.89E-06	2.89E-06	2.89E-06	0.00E+00	2.89E-06
CCMILK	0.00E+00	1.94E-05	1.94E-05	1.94E-05	1.94E-05	1.94E-05	0.00E+00	1.94E-05
IINHL	0.00E+00	7.96E-06	7.96E-06	7.96E-06	7.96E-06	7.96E-06	0.00E+00	7.96E-06
IGMILK	0.00E+00	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	0.00E+00	6.00E-05
ICMILK	0.00E+00	2.94E-05	2.94E-05	2.94E-05	2.94E-05	2.94E-05	0.00E+00	2.94E-05

=== PERIOD DOSE BY AGEGROUP, ORGAN (mrem) ===  
Agegroup Bone Liver Thyroid Kidney Lung GI-Lli Skin TB

ADULT	0.00E+00	7.60E-05	7.60E-05	7.60E-05	7.60E-05	7.60E-05	0.00E+00	7.60E-05
TEEN	0.00E+00	8.72E-05	8.72E-05	8.72E-05	8.72E-05	8.72E-05	0.00E+00	8.72E-05
CHILD	0.00E+00	1.25E-04	1.25E-04	1.25E-04	1.25E-04	1.25E-04	0.00E+00	1.25E-04
INFANT	0.00E+00	9.74E-05	9.74E-05	9.74E-05	9.74E-05	9.74E-05	0.00E+00	9.74E-05

**Table 3.1-1 (cont'd)**  
**Maximum Dose Resulting from Airborne Releases**  
**Zion Station 2012**

GASEOUS RELEASE AND DOSE SUMMARY REPORT  
(Composite Critical Receptor - Limited Analysis)

Release ID.....: 1 All Gas Releases  
Period Start Date....: 01/01/2012 00:00  
Period End Date.....: 01/01/2013 00:00  
Period Duration (min): 5.270E+05  
Coefficient Type.....: Historical  
From Unit.....: 0  
To Unit.....: 2  
Receptor.....: 5 Composite Crit. Receptor - IP  
Distance (meters)....: 0.0  
Compass Point.....: 0.0

=== MAXIMUM PERIOD DOSE TO LIMIT (Any Organ) ===  

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	LIVER	1.25E-04	31-day	2.25E-01	5.56E-02	3.00E-01	4.17E-02
				Quarter	5.63E+00	2.23E-03	7.50E+00	1.67E-03
				Annual	1.13E+01	1.11E-03	1.50E+01	8.35E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            9.98E+01

=== MAXIMUM PERIOD DOSE TO LIMIT (Tot Body) ===  

Dose Period	Age Group	Organ	Dose (mrem)	Limit Period	Admin Limit	Admin % of Limit	T.Spec Limit	T.Spec % of Limit
Strt->End	CHILD	TBODY	1.25E-04	31-day	1.50E-01	8.35E-02	2.00E-01	6.26E-02
				Quarter	5.25E+00	2.38E-03	7.50E+00	1.67E-03
				Annual	1.05E+01	1.19E-03	1.50E+01	8.35E-04

Critical Pathway.....: 2 Vegetation (VEG)  
Major Contributors.....: 0.0 % or greater to total  
Nuclide      Percentage  
-----  
H-3            9.98E+01

**Table 3.2-1**  
**Maximum dose Resulting from Liquid Effluents**  
**Zion Station 2012**

LIQUID RELEASE AND DOSE SUMMARY REPORT  
 ----- (PERIOD BASIS) -----

Release ID.....: 1 All Liquid Release Types  
 Period Start Date.....: 01/01/2012 00:00  
 Period End Date.....: 04/01/2012 00:00  
 Period Duration (mins): 1.310E+05

=== RELEASE DATA ===  
 Total Release Duration (minutes)..... 1.282E+05  
 Total Undiluted Volume Released (gallons)..... 6.945E+05  
 Average Undiluted Flowrate (gpm)..... 5.419E+00  
  
 Total Dilution Volume (gallons)..... 2.883E+09  
 Average Dilution Flowrate (gpm)..... 2.200E+04

=== NUCLIDE DATA ===

Nuclide	uCi	----Undiluted-----		-----Diluted-----	
		Average	Percent	Average	Percent
		uCi/ml	of 5*ECC	uCi/ml	of 5*EC
-----	-----	-----	-----	-----	-----

**Table 3.2-1 (cont'd)**  
**Maximum dose Resulting from Liquid Effluents**  
**Zion Station 2012**

LIQUID RELEASE AND DOSE SUMMARY REPORT  
 ----- (PERIOD BASIS) -----

Release ID.....: 1 All Liquid Release Types  
 Period Start Date.....: 04/01/2012 00:00  
 Period End Date.....: 07/01/2012 00:00  
 Period Duration (mins): 1.310E+05

=== RELEASE DATA ===  
 Total Release Duration (minutes)..... 1.310E+05  
 Total Undiluted Volume Released (gallons)..... 9.400E+05  
 Average Undiluted Flowrate (gpm)..... 7.174E+00  
  
 Total Dilution Volume (gallons)..... 9.734E+08  
 Average Dilution Flowrate (gpm)..... 7.429E+03

=== NUCLIDE DATA ===

Nuclide	uCi	----Undiluted-----		-----Diluted-----	
		Average uCi/ml	Percent of 5*ECC	Average uCi/ml	Percent of 5*EC
-----	-----	-----	-----	-----	-----

**Table 3.2-1 (cont'd)**  
**Maximum dose Resulting from Liquid Effluents**  
**Zion Station 2012**

LIQUID RELEASE AND DOSE SUMMARY REPORT  
 ----- (PERIOD BASIS) -----

Release ID.....: 1 All Liquid Release Types  
 Period Start Date.....: 07/01/2012 00:00  
 Period End Date.....: 10/01/2012 00:00  
 Period Duration (mins): 1.325E+05

=== RELEASE DATA ===  
 Total Release Duration (minutes)..... 1.325E+05  
 Total Undiluted Volume Released (gallons)..... 8.240E+05  
 Average Undiluted Flowrate (gpm)..... 6.220E+00  
  
 Total Dilution Volume (gallons)..... 3.312E+08  
 Average Dilution Flowrate (gpm)..... 2.500E+03

=== NUCLIDE DATA ===

Nuclide	uCi	----Undiluted-----		-----Diluted-----	
		Average uCi/ml	Percent of 5*ECC	Average uCi/ml	Percent of 5*EC
-----	-----	-----	-----	-----	-----

**Table 3.2-1 (cont'd)**  
**Maximum dose Resulting from Liquid Effluents**  
**Zion Station 2012**

LIQUID RELEASE AND DOSE SUMMARY REPORT  
 ----- (PERIOD BASIS) -----

Release ID.....: 1 All Liquid Release Types  
 Period Start Date.....: 10/01/2012 00:00  
 Period End Date.....: 01/01/2013 00:00  
 Period Duration (mins): 1.325E+05

=== RELEASE DATA ===  
 Total Release Duration (minutes)..... 1.325E+05  
 Total Undiluted Volume Released (gallons)..... 7.849E+05  
 Average Undiluted Flowrate (gpm)..... 5.924E+00

Total Dilution Volume (gallons)..... 3.312E+08  
 Average Dilution Flowrate (gpm)..... 2.500E+03

=== NUCLIDE DATA ===

Nuclide	uCi	----Undiluted-----		-----Diluted-----	
		Average uCi/ml	Percent of 5*ECC	Average uCi/ml	Percent of 5*EC
-----	-----	-----	-----	-----	-----

**Table 3.2-1 (cont'd)**  
**Maximum dose Resulting from Liquid Effluents**  
**Zion Station 2012**

LIQUID RELEASE AND DOSE SUMMARY REPORT  
 ----- (PERIOD BASIS) -----

Release ID.....: 1 All Liquid Release Types  
 Period Start Date.....: 01/01/2012 00:00  
 Period End Date.....: 01/01/2013 00:00  
 Period Duration (mins): 5.270E+05

=== RELEASE DATA ===  
 Total Release Duration (minutes)..... 5.242E+05  
 Total Undiluted Volume Released (gallons)..... 3.243E+06  
 Average Undiluted Flowrate (gpm)..... 6.188E+00  
  
 Total Dilution Volume (gallons)..... 4.519E+09  
 Average Dilution Flowrate (gpm)..... 8.574E+03

=== NUCLIDE DATA ===  

Nuclide	uCi	----Undiluted-----	-----Diluted-----
		Average    Percent	Average    Percent
		uCi/ml    of 5*ECC	uCi/ml    of 5*EC
-----	-----	-----	-----



**Table 3.3-1**  
**Maximum Dose Resulting from Direct Radiation**  
**Zion Station 2012**

**2012 40cfr190 evaluation of Dose From container ESUU # 500031**

Survey's indicate 40' Sealand was moved between 9-12 to 9-24 of 2012

The first working day after 9-12-12 was 9-13-12 and dose will be calculated as of this date since Survey on 9-24-12 does not indicate the survey was performed when the sealand was moved only what the current survey results are.

Days from 9-12-12 to 12-31-12

12/31/12

- 9/13/12

109 days

Exposure rate based on microshield 8.00E-03 mR/hr.

At real person location on beach area East of RRA 258' From sealand.

Occupancy factor based on TSD #13- 1200 hrs/y (1200hrs/8760hrs)

8.00E-03 mR x	0.96 mRem x	24 hr x	109 days x	1200 hrs =	<b>2.75E+00 mrem</b>
hr.	mR	day		8760 hrs	

**Table 3.4-1**  
**ZION STATION**  
**2012**

Unit 1  
10CFR20 Compliance Assessment

1. 10CFR 20.1301 (a) (1) Compliance

Total Effective Dose Equivalent **1.38E+00 mrem/year**

10 CFR 20.1301 (a) (1) limit **100 mrem/year**

% of the limit **1.38E-02**

2. Compliance Summary 10CFR20

	1 <sup>st</sup> Qtr.	2 <sup>nd</sup> Qtr.	3 <sup>rd</sup> Qtr.	4 <sup>th</sup> Qtr	% of Limit
TEDE	<b>1.68E-05</b>	<b>1.81E-05</b>	<b>1.15E-05</b>	<b>1.38E+00</b>	<b>1.38E-02</b>

**Table 3.4-1 (cont'd)**  
**ZION STATION**  
**2012**

**Unit 2**  
**10CFR20 Compliance Assessment**

1.	10CFR 20.1301 (a) (1) Compliance				
	Total Effective Dose Equivalent	<u><b>1.38E+00 mrem/year</b></u>			
	10 CFR 20.1301 (a) (1) limit	<u>100 mrem/year</u>			
	% of the limit	<u><b>1.38E-02</b></u>			
2.	Compliance Summary      10CFR20				
	1 <sup>st</sup> Qtr.	2 <sup>nd</sup> Qtr.	3 <sup>rd</sup> Qtr.	4 <sup>th</sup> Qtr	% of Limit
TEDE	<b>1.68E-05</b>	<b>1.81E-05</b>	<b>1.15E-05</b>	<b>1.38E+00</b>	<b>1.38E-02</b>

**Table 3.5-1**

**Doses Resulting from Airborne Releases**

The following are the maximum annual calculated cumulative offsite doses resulting from Zion Station airborne releases.

**Unit 1:**

<u>Dose</u>	<u>Maximum Value</u>	<u>Sector Affected</u>
gamma air <sup>(1)</sup>	0.00E+00 mrad	
beta air <sup>(2)</sup>	0.00E+00 mrad	
whole body <sup>(3)</sup>	6.80E-05 mrem	East
skin <sup>(4)</sup>	6.80E-05 mrem	East
organ <sup>(5)</sup> (child liver)	6.80E-05 mrem	East

**Unit 2:**

<u>Dose</u>	<u>Maximum Value</u>	<u>Sector Affected</u>
gamma air <sup>(1)</sup>	0.00E+00 mrad	
beta air <sup>(2)</sup>	0.00E+00 mrad	
whole body <sup>(3)</sup>	6.80E-05 mrem	East
skin <sup>(4)</sup>	6.80E-05 mrem	East
organ <sup>(5)</sup> (child liver)	6.80E-05 mrem	East

(1) Gamma Air Dose – GASPAR II, NUREG-0597

(2) Beta Air Dose – GASPAR II, NUREG-0597

(3) Whole Body Dose – GASPAR II, NUREG-0597

(4) Skin Dose – GASPAR II, NUREG-0597

(5) Inhalation and Food Pathways Dose – GASPAR II, NUREG-0597

## **APPENDIX F**

### **METEOROLOGICAL DATA**

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	0	0
NNE	0	0	5	1	0	0	6
NE	0	1	15	4	0	0	20
ENE	0	1	2	0	0	0	3
E	0	0	0	0	0	0	0
ESE	0	2	0	0	0	0	2
SE	0	0	2	0	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	1	0	1
SW	0	0	6	4	2	0	12
WSW	0	0	7	3	0	0	10
W	0	0	3	4	0	0	7
WNW	0	0	7	9	0	0	16
NW	0	0	7	1	0	0	8
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	4	54	26	3	0	87

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	0	0
NNE	0	1	2	0	0	0	3
NE	0	0	1	0	0	0	1
ENE	0	0	1	0	0	0	1
E	0	2	0	0	0	0	2
ESE	0	5	0	0	0	0	5
SE	0	1	0	0	0	0	1
SSE	0	0	1	0	0	0	1
S	0	0	0	0	0	0	0
SSW	0	1	0	4	2	0	7
SW	0	0	3	2	2	0	7
WSW	0	1	4	0	0	0	5
W	0	1	6	4	0	0	11
WNW	0	2	11	9	0	0	22
NW	0	1	6	2	0	0	9
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	15	35	21	4	0	75

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	0	0	0	1
NNE	0	2	1	2	0	0	5
NE	0	5	2	0	0	0	7
ENE	0	1	0	0	0	0	1
E	0	1	1	0	0	0	2
ESE	0	3	0	0	0	0	3
SE	0	2	1	0	0	0	3
SSE	0	0	1	1	0	0	2
S	0	1	1	0	0	0	2
SSW	0	0	5	3	4	0	12
SW	0	2	7	5	1	0	15
WSW	0	5	10	3	0	0	18
W	0	2	9	3	0	0	14
WNW	0	6	11	2	0	0	19
NW	0	0	5	2	0	0	7
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Total	0	31	55	21	5	0	112

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5



Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	11	12	10	2	0	37
NNE	3	19	13	22	0	0	57
NE	1	8	27	7	0	0	43
ENE	2	5	17	3	0	0	27
E	1	6	9	6	0	0	22
ESE	1	4	3	2	0	0	10
SE	3	8	8	4	0	0	23
SSE	2	6	14	29	25	8	84
S	1	21	32	14	0	0	68
SSW	4	26	26	18	16	0	90
SW	3	22	38	21	2	0	86
WSW	2	32	42	29	0	0	105
W	7	38	63	36	0	0	144
WNW	4	52	49	24	2	0	131
NW	0	33	37	34	0	0	104
NNW	2	19	13	13	0	0	47
Variable	0	0	0	0	0	0	0
Total	38	310	403	272	47	8	1078

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 8  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	3	12	10	0	0	0	25
NNE	4	15	10	0	0	0	29
NE	3	7	2	0	0	0	12
ENE	2	6	3	0	0	0	11
E	3	4	1	0	0	0	8
ESE	4	1	3	3	0	0	11
SE	0	5	8	0	0	0	13
SSE	3	3	11	1	0	0	18
S	6	14	17	1	0	0	38
SSW	12	11	11	3	0	0	37
SW	5	29	20	9	0	0	63
WSW	4	35	32	3	0	0	74
W	12	55	28	4	0	0	99
WNW	11	12	6	0	0	0	29
NW	4	11	3	1	0	0	19
NNW	4	5	1	0	0	0	10
Variable	1	0	0	0	0	0	1
Total	81	225	166	25	0	0	497

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	6	0	0	0	0	8
NNE	1	5	0	0	0	0	6
NE	0	1	0	0	0	0	1
ENE	0	1	0	0	0	0	1
E	1	1	0	0	0	0	2
ESE	1	0	0	0	0	0	1
SE	0	1	0	0	0	0	1
SSE	1	1	1	1	0	0	4
S	3	19	18	0	0	0	40
SSW	3	12	0	0	0	0	15
SW	8	3	0	0	0	0	11
WSW	8	6	0	0	0	0	14
W	10	7	0	0	0	0	17
WNW	3	8	0	0	0	0	11
NW	1	1	0	0	0	0	2
NNW	2	0	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Total	44	72	19	1	0	0	136

Hours of calm in this stability class: 1  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	3	0	0	0	0	3
NNE	1	4	0	0	0	0	5
NE	2	0	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	1	0	0	0	0	0	1
ESE	2	1	0	0	0	0	3
SE	0	0	1	0	0	0	1
SSE	1	5	10	0	0	0	16
S	7	57	41	3	0	0	108
SSW	7	7	0	0	0	0	14
SW	2	0	0	0	0	0	2
WSW	1	0	0	0	0	0	1
W	5	10	0	0	0	0	15
WNW	2	5	0	0	0	0	7
NW	3	0	0	0	0	0	3
NNW	1	0	0	0	0	0	1
Variable	0	1	0	0	0	0	1
Total	36	93	52	3	0	0	184

Hours of calm in this stability class: 1  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	0	0
NNE	0	0	1	5	2	0	8
NE	0	0	7	10	2	0	19
ENE	0	1	0	1	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	2	0	0	0	2
SE	0	0	0	0	2	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	1	1
SW	0	0	0	5	2	1	8
WSW	0	0	4	6	1	2	13
W	0	0	0	1	1	2	4
WNW	0	0	2	8	11	0	21
NW	0	0	0	6	1	0	7
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	1	16	42	22	6	87

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	0	0
NNE	0	0	2	2	0	0	4
NE	0	1	0	0	0	0	1
ENE	0	0	0	1	0	0	1
E	0	0	1	0	0	0	1
ESE	0	3	2	0	0	0	5
SE	0	0	1	1	0	0	2
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	1	1	2	2	6
SW	0	0	1	1	0	5	7
WSW	0	0	3	2	0	0	5
W	0	0	3	2	1	2	8
WNW	0	0	5	10	9	0	24
NW	0	0	1	7	3	0	11
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	4	20	27	15	9	75

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	0	0	0	1
NNE	0	1	2	2	0	2	7
NE	0	4	0	1	0	0	5
ENE	0	2	0	0	0	0	2
E	0	0	1	0	0	0	1
ESE	0	1	2	0	0	0	3
SE	0	0	2	0	1	0	3
SSE	0	0	1	1	0	0	2
S	0	0	1	1	0	0	2
SSW	0	0	4	1	2	5	12
SW	0	0	5	3	1	3	12
WSW	0	0	9	5	1	4	19
W	0	0	8	3	2	1	14
WNW	0	0	7	8	5	0	20
NW	0	1	4	2	2	0	9
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	9	47	27	14	15	112

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	4	4	9	11	3	33
NNE	1	9	21	14	11	13	69
NE	0	5	9	13	11	2	40
ENE	0	3	12	12	1	0	28
E	1	1	3	7	4	0	16
ESE	2	3	5	3	2	2	17
SE	0	5	6	4	8	3	26
SSE	0	6	4	14	23	32	79
S	2	3	15	21	23	3	67
SSW	0	6	17	18	9	29	79
SW	0	3	30	26	20	6	85
WSW	1	8	25	28	28	9	99
W	0	11	27	40	49	10	137
WNW	1	9	42	36	29	16	133
NW	0	5	23	32	45	13	118
NNW	0	8	16	20	13	3	60
Variable	0	0	0	0	0	0	0
Total	10	89	259	297	287	144	1086

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5



Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	3	3	14	1	0	22
NNE	0	6	11	11	4	0	32
NE	3	2	5	1	2	0	13
ENE	1	4	2	2	0	0	9
E	2	6	1	3	0	0	12
ESE	0	3	4	1	5	4	17
SE	1	2	2	1	3	3	12
SSE	2	4	5	9	9	1	30
S	1	5	6	9	4	0	25
SSW	0	6	3	3	9	1	22
SW	1	5	8	22	23	1	60
WSW	1	2	13	35	16	1	68
W	1	1	19	61	17	0	99
WNW	0	5	13	17	6	0	41
NW	0	5	3	12	2	0	22
NNW	0	3	3	7	0	0	13
Variable	0	0	0	0	0	0	0
Total	14	62	101	208	101	11	497

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	4	2	0	0	6
NNE	2	3	1	0	0	0	6
NE	0	1	1	1	0	0	3
ENE	0	2	3	0	0	0	5
E	0	3	0	0	0	0	3
ESE	2	2	1	0	0	0	5
SE	0	1	1	4	1	0	7
SSE	1	1	4	7	10	1	24
S	0	5	6	1	8	0	20
SSW	0	1	6	6	0	0	13
SW	0	0	2	8	0	0	10
WSW	1	0	0	6	0	0	7
W	0	3	4	1	0	0	8
WNW	0	0	3	4	0	0	7
NW	0	1	4	3	0	0	8
NNW	0	3	0	2	0	0	5
Variable	0	0	0	0	0	0	0
Total	6	26	40	45	19	1	137

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: January - March 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	2	0	0	0	0	3
NNE	0	0	2	0	0	0	2
NE	2	2	3	1	0	0	8
ENE	1	2	0	0	0	0	3
E	1	1	0	0	0	0	2
ESE	0	1	0	0	0	0	1
SE	1	0	2	5	0	0	8
SSE	0	0	1	13	18	5	37
S	1	1	10	23	18	2	55
SSW	0	0	12	23	5	0	40
SW	0	1	2	4	0	0	7
WSW	0	0	1	0	0	0	1
W	1	1	0	0	0	0	2
WNW	0	0	1	0	0	0	1
NW	0	2	3	3	0	0	8
NNW	0	3	4	0	0	0	7
Variable	0	0	0	0	0	0	0
Total	8	16	41	72	41	7	185

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 5

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	1	2	0	0	4
NNE	0	5	51	19	0	0	75
NE	0	3	16	3	0	0	22
ENE	0	2	13	0	0	0	15
E	0	7	3	0	0	0	10
ESE	0	11	9	0	0	0	20
SE	0	10	1	0	0	0	11
SSE	0	0	3	0	0	0	3
S	0	0	1	0	0	0	1
SSW	0	0	1	6	0	0	7
SW	0	0	8	11	0	0	19
WSW	0	0	13	8	0	0	21
W	0	1	22	3	1	0	27
WNW	0	1	2	7	0	0	10
NW	0	0	4	2	0	0	6
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	41	148	61	1	0	251

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)

Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	2	2	2	0	0	6
NNE	0	5	11	0	0	0	16
NE	0	4	0	1	0	0	5
ENE	0	2	1	1	0	0	4
E	0	2	0	0	0	0	2
ESE	0	2	1	0	0	0	3
SE	0	1	0	0	0	0	1
SSE	0	0	1	0	0	0	1
S	0	0	3	0	0	0	3
SSW	0	0	3	2	0	0	5
SW	0	1	5	4	2	0	12
WSW	0	1	1	0	1	0	3
W	0	0	5	3	0	0	8
WNW	0	3	3	2	0	0	8
NW	0	1	5	0	0	0	6
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	24	41	15	3	0	83

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)

Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	8	7	0	0	16
NNE	0	8	19	3	0	0	30
NE	0	12	4	0	0	0	16
ENE	0	2	1	3	0	0	6
E	0	2	1	0	0	0	3
ESE	0	4	0	0	0	0	4
SE	0	4	0	0	0	0	4
SSE	0	3	6	0	0	0	9
S	0	0	2	0	0	0	2
SSW	0	0	2	5	1	0	8
SW	0	3	5	3	3	0	14
WSW	0	2	3	0	1	0	6
W	0	2	2	3	1	0	8
WNW	0	3	1	1	0	0	5
NW	0	2	6	1	0	0	9
NNW	0	1	2	0	0	0	3
Variable	0	0	0	0	0	0	0
Total	0	49	62	26	6	0	143

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	12	45	22	6	0	87
NNE	3	27	51	27	0	0	108
NE	5	17	15	2	0	0	39
ENE	2	13	15	6	0	0	36
E	2	11	10	9	1	0	33
ESE	5	19	6	4	0	0	34
SE	1	18	2	0	0	0	21
SSE	2	21	15	6	0	0	44
S	1	12	19	2	0	0	34
SSW	0	7	20	10	0	0	37
SW	0	9	32	13	4	0	58
WSW	0	6	4	1	0	0	11
W	2	13	14	2	0	0	31
WNW	1	9	20	0	0	0	30
NW	0	9	11	1	0	0	21
NNW	2	9	15	1	0	0	27
Variable	0	0	0	0	0	0	0
Total	28	212	294	106	11	0	651

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	3	36	16	4	0	0	59
NNE	6	33	18	2	0	0	59
NE	3	8	5	0	0	0	16
ENE	3	7	2	0	0	0	12
E	4	14	2	3	0	0	23
ESE	3	13	3	0	0	0	19
SE	7	15	2	0	0	0	24
SSE	6	24	27	2	1	0	60
S	4	37	32	5	1	0	79
SSW	12	25	13	1	0	0	51
SW	6	12	6	1	0	0	25
WSW	2	14	3	0	0	0	19
W	1	25	8	1	0	0	35
WNW	4	19	3	0	0	0	26
NW	3	18	7	0	0	0	28
NNW	5	15	3	0	0	0	23
Variable	1	0	0	0	0	0	1
Total	73	315	150	19	2	0	559

Hours of calm in this stability class: 1

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2



Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	4	3	0	0	0	0	7
NNE	2	5	0	0	0	0	7
NE	2	5	0	0	0	0	7
ENE	2	3	3	0	0	0	8
E	4	6	0	1	0	0	11
ESE	4	6	1	0	0	0	11
SE	1	10	3	0	0	0	14
SSE	4	12	32	4	1	0	53
S	7	30	20	4	0	0	61
SSW	11	29	2	0	0	0	42
SW	11	12	1	0	0	0	24
WSW	10	12	1	0	0	0	23
W	6	7	0	0	0	0	13
WNW	6	8	1	0	0	0	15
NW	8	10	0	0	0	0	18
NNW	3	1	0	0	0	0	4
Variable	0	0	0	0	0	0	0
Total	85	159	64	9	1	0	318

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	4	1	0	0	0	0	5
NNE	0	0	0	0	0	0	0
NE	0	2	0	0	0	0	2
ENE	0	0	1	0	0	0	1
E	0	0	2	0	0	0	2
ESE	0	2	0	0	0	0	2
SE	3	2	2	0	0	0	7
SSE	3	3	6	0	0	0	12
S	5	27	22	0	0	0	54
SSW	13	10	0	0	0	0	23
SW	5	9	0	0	0	0	14
WSW	13	6	0	0	0	0	19
W	12	10	0	0	0	0	22
WNW	2	4	0	0	0	0	6
NW	3	0	0	0	0	0	3
NNW	4	0	0	0	0	0	4
Variable	0	0	0	0	0	0	0
Total	67	76	33	0	0	0	176

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	3	1	0	5
NNE	0	1	29	40	10	1	81
NE	0	0	12	2	1	0	15
ENE	0	4	6	6	0	0	16
E	0	4	6	3	1	0	14
ESE	0	2	14	0	0	0	16
SE	0	2	7	4	0	0	13
SSE	0	0	0	0	0	0	0
S	0	0	0	1	0	0	1
SSW	0	0	0	1	3	2	6
SW	0	0	1	8	8	1	18
WSW	0	0	2	7	10	1	20
W	0	0	3	18	3	4	28
WNW	0	0	2	1	4	4	11
NW	0	0	1	4	2	0	7
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	13	84	98	43	13	251

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	3	1	1	6
NNE	0	0	11	4	1	0	16
NE	0	1	4	0	1	0	6
ENE	0	0	0	2	0	0	2
E	0	1	1	0	0	0	2
ESE	0	2	2	0	0	0	4
SE	0	1	0	0	0	0	1
SSE	0	0	0	0	1	0	1
S	0	0	0	3	0	0	3
SSW	0	0	0	2	1	0	3
SW	0	0	0	3	5	1	9
WSW	0	0	1	4	0	2	7
W	0	0	3	1	1	2	7
WNW	0	0	5	1	2	1	9
NW	0	0	3	4	0	0	7
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	0	5	31	27	13	7	83

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	0	7	7	3	18
NNE	0	0	22	7	2	1	32
NE	0	3	8	1	0	0	12
ENE	0	1	1	1	3	0	6
E	0	1	1	0	1	0	3
ESE	0	1	3	1	0	0	5
SE	0	2	4	1	0	0	7
SSE	0	1	0	4	1	0	6
S	0	0	0	0	0	0	0
SSW	0	0	0	2	4	2	8
SW	0	1	1	5	3	4	14
WSW	0	1	1	2	0	1	5
W	0	1	2	2	1	4	10
WNW	0	1	2	1	0	1	5
NW	0	2	1	5	2	0	10
NNW	0	0	0	2	0	0	2
Variable	0	0	0	0	0	0	0
Total	0	16	46	41	24	16	143

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	4	8	27	39	14	93
NNE	1	7	24	37	35	3	107
NE	2	5	9	13	4	0	33
ENE	1	6	10	16	8	0	41
E	1	6	11	9	7	2	36
ESE	0	7	8	8	6	0	29
SE	1	8	17	9	0	0	35
SSE	0	3	14	15	5	0	37
S	0	3	3	12	5	1	24
SSW	0	4	4	8	12	3	31
SW	0	1	7	25	18	8	59
WSW	0	1	4	10	1	0	16
W	0	4	4	12	7	1	28
WNW	0	3	7	17	5	0	32
NW	0	2	5	16	3	0	26
NNW	0	3	7	14	0	0	24
Variable	0	0	0	0	0	0	0
Total	7	67	142	248	155	32	651

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	2	9	31	9	1	52
NNE	0	2	11	33	6	1	53
NE	0	3	14	7	4	0	28
ENE	2	3	16	2	4	0	27
E	0	8	9	1	5	0	23
ESE	1	4	12	6	6	0	29
SE	1	4	13	12	6	0	36
SSE	1	10	28	33	6	3	81
S	1	2	10	26	9	3	51
SSW	0	6	3	20	1	0	30
SW	0	0	7	17	1	1	26
WSW	1	4	4	19	0	0	28
W	0	0	3	11	6	1	21
WNW	0	2	7	24	2	0	35
NW	0	2	3	18	1	0	24
NNW	0	1	5	10	0	0	16
Variable	0	0	0	0	0	0	0
Total	7	53	154	270	66	10	560

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	4	4	1	0	0	9
NNE	0	4	3	2	0	0	9
NE	0	0	4	2	0	0	6
ENE	0	1	4	2	4	0	11
E	0	6	7	5	1	1	20
ESE	0	3	4	6	1	1	15
SE	1	4	4	8	9	4	30
SSE	2	1	20	19	9	4	55
S	0	6	15	28	12	2	63
SSW	0	1	7	21	1	0	30
SW	0	0	3	12	3	0	18
WSW	0	2	2	8	5	0	17
W	0	0	4	0	4	0	8
WNW	0	2	3	2	0	0	7
NW	0	0	2	7	2	0	11
NNW	0	0	4	5	0	0	9
Variable	0	0	0	0	0	0	0
Total	3	34	90	128	51	12	318

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2



Zion Nuclear Station

Period of Record: April - June 2012

Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	2	0	0	0	0	2
NNE	0	0	0	0	0	0	0
NE	0	1	1	0	0	0	2
ENE	0	4	3	1	0	0	8
E	0	1	0	0	1	0	2
ESE	1	0	0	0	1	4	6
SE	0	1	1	1	1	0	4
SSE	1	3	4	2	3	0	13
S	1	5	9	26	12	2	55
SSW	0	1	9	31	2	0	43
SW	1	1	3	6	1	0	12
WSW	0	0	1	6	2	0	9
W	1	1	1	0	0	0	3
WNW	1	3	1	1	2	0	8
NW	0	0	1	2	0	0	3
NNW	1	3	2	0	0	0	6
Variable	0	0	0	0	0	0	0
Total	7	26	36	76	25	6	176

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	2	5	0	0	8
NNE	0	6	33	8	0	0	47
NE	0	29	39	1	0	0	69
ENE	0	21	12	0	0	0	33
E	1	21	9	0	0	0	31
ESE	0	16	4	0	0	0	20
SE	0	20	13	0	0	0	33
SSE	0	1	22	0	0	0	23
S	0	2	1	2	0	0	5
SSW	0	0	3	0	0	0	3
SW	0	4	9	9	0	0	22
WSW	0	9	20	1	0	0	30
W	0	3	13	0	0	0	16
WNW	0	2	9	2	0	0	13
NW	0	6	12	0	0	0	18
NNW	0	0	2	0	0	0	2
Variable	0	0	0	0	0	0	0
Total	1	141	203	28	0	0	373

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	0	3	1	0	0	5
NNE	0	7	1	1	0	0	9
NE	0	10	4	1	0	0	15
ENE	1	3	2	0	0	0	6
E	0	6	0	0	0	0	6
ESE	0	2	0	0	0	0	2
SE	0	5	0	0	0	0	5
SSE	0	5	12	2	0	0	19
S	0	2	0	1	0	0	3
SSW	0	1	5	1	0	0	7
SW	0	3	3	1	0	0	7
WSW	0	7	6	0	0	0	13
W	0	2	3	0	0	0	5
WNW	0	5	1	0	0	0	6
NW	0	4	8	0	0	0	12
NNW	1	0	3	0	0	0	4
Variable	0	0	0	0	0	0	0
Total	3	62	51	8	0	0	124

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	2	7	4	0	0	13
NNE	0	7	5	1	0	0	13
NE	0	12	12	2	0	0	26
ENE	1	9	5	0	0	0	15
E	0	9	2	0	0	0	11
ESE	0	2	0	0	0	0	2
SE	0	7	1	0	0	0	8
SSE	1	8	30	3	0	0	42
S	0	7	6	0	0	0	13
SSW	1	7	8	2	0	0	18
SW	0	4	4	4	0	0	12
WSW	1	7	6	0	0	0	14
W	1	9	1	0	0	0	11
WNW	1	3	4	0	0	0	8
NW	1	5	2	0	0	0	8
NNW	1	1	4	0	0	0	6
Variable	0	0	0	0	0	0	0
Total	8	99	97	16	0	0	220

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	9	24	5	0	0	40
NNE	3	20	20	1	0	0	44
NE	4	18	14	2	0	0	38
ENE	2	16	9	5	0	0	32
E	6	14	3	2	0	0	25
ESE	5	8	0	0	0	0	13
SE	6	16	3	0	0	0	25
SSE	2	19	33	4	0	0	58
S	3	35	12	0	0	0	50
SSW	5	9	9	5	0	0	28
SW	9	17	18	2	0	0	46
WSW	3	16	17	0	0	0	36
W	1	11	12	0	0	0	24
WNW	5	26	4	2	0	0	37
NW	5	20	19	1	0	0	45
NNW	1	12	14	0	0	0	27
Variable	0	1	0	0	0	0	1
Total	62	267	211	29	0	0	569

Hours of calm in this stability class: 2  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	6	19	1	0	0	0	26
NNE	5	19	8	0	0	0	32
NE	7	12	1	0	0	0	20
ENE	6	3	0	0	0	0	9
E	7	4	0	0	0	0	11
ESE	1	3	0	0	0	0	4
SE	7	2	4	0	0	0	13
SSE	5	2	11	0	0	0	18
S	5	36	3	0	0	0	44
SSW	10	66	6	1	0	0	83
SW	9	30	17	0	0	0	56
WSW	12	46	5	0	0	0	63
W	10	23	5	0	0	0	38
WNW	11	21	1	1	0	0	34
NW	11	23	5	0	0	0	39
NNW	5	15	0	0	0	0	20
Variable	0	0	0	0	0	0	0
Total	117	324	67	2	0	0	510

Hours of calm in this stability class: 4  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	1	0	0	0	0	3
NNE	2	1	0	0	0	0	3
NE	2	0	0	0	0	0	2
ENE	1	0	0	0	0	0	1
E	1	1	0	0	0	0	2
ESE	1	1	0	0	0	0	2
SE	0	1	0	0	0	0	1
SSE	1	1	0	0	0	0	2
S	4	11	0	0	0	0	15
SSW	12	19	0	0	0	0	31
SW	13	9	0	0	0	0	22
WSW	19	13	0	0	0	0	32
W	35	22	0	0	0	0	57
WNW	10	15	0	0	0	0	25
NW	4	9	0	0	0	0	13
NNW	4	2	0	0	0	0	6
Variable	0	0	0	0	0	0	0
Total	111	106	0	0	0	0	217

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	4	1	0	0	0	0	5
SW	2	9	0	0	0	0	11
WSW	23	27	0	0	0	0	50
W	22	43	0	0	0	0	65
WNW	5	20	0	0	0	0	25
NW	1	11	0	0	0	0	12
NNW	1	1	0	0	0	0	2
Variable	0	0	0	0	0	0	0
Total	58	112	0	0	0	0	170

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station



Period of Record: July - September 2012  
Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	2	1	4	8
NNE	0	3	23	19	7	2	54
NE	0	4	43	15	2	0	64
ENE	0	4	23	6	2	0	35
E	0	10	12	4	0	0	26
ESE	0	9	11	1	0	0	21
SE	0	0	29	8	0	0	37
SSE	0	0	13	6	0	0	19
S	0	0	1	2	1	0	4
SSW	0	0	0	3	0	1	4
SW	0	0	3	2	8	0	13
WSW	0	0	12	15	2	0	29
W	0	0	9	15	0	0	24
WNW	0	0	3	9	0	0	12
NW	0	0	9	8	3	0	20
NNW	0	0	1	2	0	0	3
Variable	0	0	0	0	0	0	0
Total	0	30	193	117	26	7	373

Hours of calm in this stability class: 0  
Hours of missing wind measurements in this stability class: 0  
Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	0	2	1	0	4
NNE	0	3	4	3	1	0	11
NE	0	6	1	1	4	0	12
ENE	1	3	3	0	1	0	8
E	0	6	1	0	0	0	7
ESE	0	1	0	0	0	0	1
SE	0	1	4	1	0	0	6
SSE	0	1	12	3	0	1	17
S	0	1	1	0	1	0	3
SSW	0	0	2	2	2	1	7
SW	0	1	3	2	1	0	7
WSW	0	2	5	2	0	0	9
W	0	2	4	3	0	0	9
WNW	0	2	2	2	0	0	6
NW	0	1	5	7	0	0	13
NNW	0	1	0	2	1	0	4
Variable	0	0	0	0	0	0	0
Total	1	32	47	30	12	2	124

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	1	6	4	1	13
NNE	0	2	7	4	2	1	16
NE	0	5	6	5	8	1	25
ENE	0	3	4	8	0	0	15
E	0	2	3	2	0	0	7
ESE	0	1	2	0	0	0	3
SE	0	1	6	3	0	0	10
SSE	1	1	25	11	1	0	39
S	0	2	5	5	1	0	13
SSW	0	1	6	6	2	1	16
SW	0	2	5	3	3	0	13
WSW	0	3	3	6	1	0	13
W	0	3	8	3	1	0	15
WNW	0	0	3	3	0	0	6
NW	0	3	4	3	0	0	10
NNW	0	1	1	4	0	0	6
Variable	0	0	0	0	0	0	0
Total	1	31	89	72	23	4	220

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	7	4	19	15	0	46
NNE	0	2	10	23	3	0	38
NE	0	4	10	19	4	1	38
ENE	0	7	10	5	9	3	34
E	3	5	13	2	5	0	28
ESE	1	9	6	2	0	0	18
SE	1	12	8	6	0	0	27
SSE	1	7	28	16	4	0	56
S	1	3	25	16	0	0	45
SSW	0	5	6	10	1	4	26
SW	2	6	9	7	11	0	35
WSW	0	6	8	18	7	0	39
W	0	3	9	21	1	0	34
WNW	0	4	7	14	1	1	27
NW	1	3	9	28	2	3	46
NNW	0	2	5	26	0	0	33
Variable	0	1	0	0	0	0	1
Total	11	86	167	232	63	12	571

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012

Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	4	10	11	0	0	26
NNE	0	6	15	20	0	0	41
NE	0	5	5	5	1	0	16
ENE	0	9	4	2	0	0	15
E	3	8	10	1	0	0	22
ESE	0	7	2	1	0	0	10
SE	0	8	8	1	1	0	18
SSE	1	5	8	8	1	0	23
S	1	5	12	36	0	0	54
SSW	1	5	13	35	1	1	56
SW	0	5	12	36	6	0	59
WSW	1	4	9	42	4	0	60
W	0	3	4	30	1	0	38
WNW	0	1	8	13	0	0	22
NW	0	1	15	22	1	0	39
NNW	1	2	4	8	0	0	15
Variable	0	0	0	0	0	0	0
Total	9	78	139	271	16	1	514

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	2	0	2	2	0	0	6
NNE	2	4	5	1	0	0	12
NE	1	0	1	0	0	0	2
ENE	1	1	2	0	0	0	4
E	0	4	1	1	0	0	6
ESE	1	2	1	2	0	0	6
SE	0	1	1	0	0	0	2
SSE	2	3	5	1	0	0	11
S	1	5	9	13	0	0	28
SSW	2	5	12	13	1	0	33
SW	0	6	6	6	2	0	20
WSW	1	2	4	10	2	0	19
W	1	4	1	13	4	0	23
WNW	1	1	5	4	1	0	12
NW	3	3	7	11	1	0	25
NNW	1	0	4	3	0	0	8
Variable	0	0	0	0	0	0	0
Total	19	41	66	80	11	0	217

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: July - September 2012

Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)

Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	3	6	5	0	0	15
NNE	0	3	6	0	0	0	9
NE	0	0	1	0	0	0	1
ENE	2	0	1	0	0	0	3
E	1	0	0	0	0	0	1
ESE	3	0	0	0	0	0	3
SE	0	1	0	0	0	0	1
SSE	2	1	1	0	0	0	4
S	1	0	1	0	0	0	2
SSW	1	5	2	3	0	0	11
SW	0	8	5	10	2	0	25
WSW	0	1	6	17	4	0	28
W	1	5	8	19	1	0	34
WNW	1	4	5	2	1	0	13
NW	1	3	5	3	0	0	12
NNW	2	3	1	2	0	0	8
Variable	0	0	0	0	0	0	0
Total	16	37	48	61	8	0	170

Hours of calm in this stability class: 0

Hours of missing wind measurements in this stability class: 0

Hours of missing stability measurements in all stability classes: 19

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	1	6	0	0	7
NNE	0	1	22	2	0	0	25
NE	0	4	4	1	0	0	9
ENE	0	2	3	0	0	0	5
E	0	1	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	4	0	0	0	0	4
SSE	0	2	8	1	0	0	11
S	0	0	4	1	0	0	5
SSW	0	0	4	14	0	0	18
SW	0	1	7	7	0	0	15
WSW	0	6	4	4	0	0	14
W	0	6	6	3	0	0	15
WNW	0	4	7	1	0	0	12
NW	0	2	7	0	0	0	9
NNW	0	0	7	1	0	0	8
Variable	0	0	0	0	0	0	0
Total	0	34	84	41	0	0	159

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2



Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	1	0	0	1
NNE	0	2	4	0	0	0	6
NE	0	2	0	0	0	0	2
ENE	0	2	2	0	0	0	4
E	0	1	1	0	0	0	2
ESE	0	0	1	0	0	0	1
SE	0	1	0	0	0	0	1
SSE	0	4	5	1	0	0	10
S	0	0	3	2	0	0	5
SSW	0	3	3	3	0	0	9
SW	0	1	5	2	1	0	9
WSW	0	2	1	2	0	0	5
W	0	2	2	0	0	0	4
WNW	0	2	2	2	1	0	7
NW	0	2	6	0	0	0	8
NNW	0	2	1	2	0	0	5
Variable	0	0	0	0	0	0	0
Total	0	26	36	15	2	0	79

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	2	6	1	0	0	10
NNE	0	2	7	0	0	0	9
NE	0	4	1	1	0	0	6
ENE	0	2	0	0	0	0	2
E	0	5	1	0	0	0	6
ESE	3	3	0	0	0	0	6
SE	2	3	0	0	0	0	5
SSE	0	7	5	2	1	0	15
S	1	6	5	1	0	0	13
SSW	0	3	5	10	0	0	18
SW	0	2	7	3	0	0	12
WSW	0	2	5	1	0	0	8
W	0	5	8	2	0	0	15
WNW	1	1	7	2	0	0	11
NW	1	7	9	1	0	0	18
NNW	0	4	6	3	0	0	13
Variable	0	0	0	0	0	0	0
Total	9	58	72	27	1	0	167

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	13	15	8	0	0	36
NNE	5	15	17	11	0	0	48
NE	4	16	11	9	2	0	42
ENE	1	11	11	5	1	0	29
E	2	9	10	9	6	0	36
ESE	1	11	3	15	3	0	33
SE	3	9	2	1	0	0	15
SSE	0	11	20	17	7	0	55
S	2	19	33	3	3	0	60
SSW	4	42	40	21	6	0	113
SW	7	22	50	33	0	0	112
WSW	12	17	22	1	0	0	52
W	12	27	46	13	0	0	98
WNW	11	36	37	9	0	0	93
NW	10	42	44	19	8	0	123
NNW	1	32	52	21	0	0	106
Variable	0	0	0	0	0	0	0
Total	75	332	413	195	36	0	1051

Hours of calm in this stability class: 1  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	6	13	5	0	0	0	24
NNE	3	13	2	0	0	0	18
NE	3	1	0	0	0	0	4
ENE	2	2	0	0	0	0	4
E	3	3	0	0	0	0	6
ESE	3	2	0	0	0	0	5
SE	4	2	0	0	0	0	6
SSE	2	10	8	0	0	0	20
S	8	67	22	2	0	0	99
SSW	9	47	26	0	0	0	82
SW	10	26	12	2	0	0	50
WSW	8	15	2	0	0	0	25
W	7	32	16	0	0	0	55
WNW	7	32	10	0	0	0	49
NW	7	48	1	0	0	0	56
NNW	2	26	6	0	0	0	34
Variable	0	0	0	0	0	0	0
Total	84	339	110	4	0	0	537

Hours of calm in this stability class: 1  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	0	0	0	0	0	1
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	1	0	0	0	0	0	1
E	0	0	0	0	0	0	0
ESE	1	0	0	0	0	0	1
SE	1	2	1	0	0	0	4
SSE	0	2	4	0	0	0	6
S	3	28	13	1	0	0	45
SSW	4	8	2	0	0	0	14
SW	5	15	1	0	0	0	21
WSW	4	6	0	0	0	0	10
W	4	5	0	0	0	0	9
WNW	2	0	0	0	0	0	2
NW	3	18	0	0	0	0	21
NNW	1	3	0	0	0	0	4
Variable	0	0	0	0	0	0	0
Total	31	87	21	1	0	0	140

Hours of calm in this stability class: 1  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 35 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	0	0	0	0	0	1
NNE	1	0	0	0	0	0	1
NE	0	0	0	0	0	0	0
ENE	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	1	2	0	0	0	3
S	2	4	5	0	0	0	11
SSW	4	1	0	0	0	0	5
SW	4	12	0	0	0	0	16
WSW	8	6	0	0	0	0	14
W	4	1	0	0	0	0	5
WNW	6	1	0	0	0	0	7
NW	5	1	0	0	0	0	6
NNW	0	1	0	0	0	0	1
Variable	0	0	0	0	0	0	0
Total	35	28	7	0	0	0	70

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Extremely Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	1	3	3	7
NNE	0	1	14	11	2	0	28
NE	0	2	3	1	1	0	7
ENE	0	0	2	2	0	0	4
E	0	1	0	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	0	6	0	0	0	6
SSE	0	2	1	3	0	0	6
S	0	0	1	5	0	0	6
SSW	0	0	3	2	9	5	19
SW	0	1	2	6	4	0	13
WSW	0	1	6	0	0	2	9
W	0	4	11	0	6	0	21
WNW	0	0	7	5	0	1	13
NW	0	0	2	6	0	0	8
NNW	0	1	2	6	1	0	10
Variable	0	0	0	0	0	0	0
Total	0	14	60	48	26	11	159

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Moderately Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	0	0	0	1	1
NNE	0	1	3	2	0	0	6
NE	0	1	1	0	0	0	2
ENE	0	1	1	2	0	0	4
E	0	0	0	1	0	0	1
ESE	0	0	2	0	0	0	2
SE	0	0	1	1	0	0	2
SSE	0	2	3	0	1	0	6
S	0	0	2	4	0	2	8
SSW	0	0	3	1	2	0	6
SW	0	2	1	4	2	1	10
WSW	0	2	2	0	1	0	5
W	0	0	4	0	1	0	5
WNW	0	1	0	2	0	3	6
NW	0	1	3	6	0	0	10
NNW	0	2	0	1	0	2	5
Variable	0	0	0	0	0	0	0
Total	0	13	26	24	7	9	79

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2



Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Slightly Unstable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	1	3	5	2	1	12
NNE	0	1	4	5	0	0	10
NE	0	1	3	1	1	0	6
ENE	1	1	2	0	0	0	4
E	1	2	2	0	0	0	5
ESE	1	5	0	0	0	0	6
SE	0	4	1	0	0	0	5
SSE	0	2	2	3	2	0	9
S	0	2	10	4	0	0	16
SSW	0	1	5	1	4	3	14
SW	0	1	3	7	5	0	16
WSW	0	1	1	2	1	0	5
W	0	4	3	8	1	1	17
WNW	0	2	1	6	1	2	12
NW	0	4	7	7	1	1	20
NNW	0	3	4	2	0	1	10
Variable	0	0	0	0	0	0	0
Total	3	35	51	51	18	9	167

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Neutral - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	2	12	18	12	2	46
NNE	1	3	12	15	4	8	43
NE	1	4	15	11	2	9	42
ENE	1	3	16	8	2	3	33
E	1	4	4	11	7	6	33
ESE	0	10	5	1	14	6	36
SE	1	4	13	3	1	3	25
SSE	1	1	9	13	11	7	42
S	0	1	18	26	16	2	63
SSW	1	6	25	33	21	11	97
SW	0	8	23	38	39	10	118
WSW	0	7	10	21	6	0	44
W	1	9	20	45	15	9	99
WNW	0	10	21	29	18	1	79
NW	1	14	27	43	24	19	128
NNW	0	0	38	57	20	5	120
Variable	0	0	0	0	0	0	0
Total	9	86	268	372	212	101	1048

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 4  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Slightly Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	1	3	16	10	3	0	33
NNE	1	3	10	4	0	0	18
NE	0	5	6	1	0	0	12
ENE	0	3	3	0	0	0	6
E	1	3	3	0	0	0	7
ESE	0	6	4	1	0	0	11
SE	0	2	4	2	0	0	8
SSE	0	6	12	16	5	0	39
S	2	1	16	40	13	0	72
SSW	0	3	15	43	9	0	70
SW	1	7	19	28	9	0	64
WSW	0	3	10	9	0	0	22
W	0	4	7	24	0	0	35
WNW	1	0	11	32	1	0	45
NW	0	1	8	32	4	0	45
NNW	0	3	4	40	2	0	49
Variable	0	0	0	0	0	0	0
Total	7	53	148	282	46	0	536

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 2  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Moderately Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	7	5	0	0	12
NNE	0	0	5	1	0	0	6
NE	0	0	1	0	0	0	1
ENE	0	1	1	0	0	0	2
E	0	0	0	0	0	0	0
ESE	0	0	1	0	0	0	1
SE	0	0	1	1	0	0	2
SSE	0	2	2	8	1	0	13
S	0	1	9	25	8	0	43
SSW	0	1	6	10	3	0	20
SW	0	0	2	7	3	0	12
WSW	1	1	1	8	0	0	11
W	0	0	3	4	0	0	7
WNW	0	2	0	3	0	0	5
NW	0	0	0	0	0	0	0
NNW	0	0	1	5	0	0	6
Variable	0	0	0	0	0	0	0
Total	1	8	40	77	15	0	141

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

Zion Nuclear Station

Period of Record: October - December 2012  
 Stability Class - Extremely Stable - 250Ft-33Ft Delta-T (F)  
 Winds Measured at 250 Feet

Wind Direction	Wind Speed (in mph)						Total
	1-3	4-7	8-12	13-18	19-24	> 24	
N	0	0	2	0	0	0	2
NNE	0	1	0	1	0	0	2
NE	0	3	1	0	0	0	4
ENE	0	0	2	0	0	0	2
E	1	0	1	0	0	0	2
ESE	1	0	0	0	0	0	1
SE	1	1	1	0	0	0	3
SSE	0	0	0	0	0	0	0
S	1	0	1	3	6	0	11
SSW	0	0	6	2	0	0	8
SW	1	2	6	11	3	0	23
WSW	0	0	3	7	0	0	10
W	0	0	0	0	0	0	0
WNW	0	0	2	0	0	0	2
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Variable	0	0	0	0	0	0	0
Total	5	7	25	24	9	0	70

Hours of calm in this stability class: 0  
 Hours of missing wind measurements in this stability class: 0  
 Hours of missing stability measurements in all stability classes: 2

## **APPENDIX G**

### **ANNUAL RADIOLOGICAL GROUNDWATER PROTECTION PROGRAM REPORT (ARGPPR)**

Docket No: 50-295  
50-304

# **ZION NUCLEAR POWER STATION UNITS 1 and 2**

Annual Radiological  
Groundwater Protection Program Report

1 January Through 31 December 2012

**Prepared By**

Teledyne Brown Engineering  
Environmental Services



Zion Nuclear Power Station  
Zion, IL 60099

**May 2013**

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## Appendices

### Appendix A      Location and Direction

#### Tables

Table A-1      Radiological Groundwater Protection Program - Sampling Locations and Distance, Zion Nuclear Power Station, 2012

#### Figures

Figure A-1      Radiological Groundwater Protection Program Groundwater and Surface Water Locations of the Zion Nuclear Power Station, 2012

### Appendix B      Data Tables

#### Tables

Table B-I.1      Concentrations of Tritium, Strontium, Gross Alpha, and Gross Beta in Groundwater Samples Collected in the Vicinity of Zion Nuclear Power Station, 2012.

Table B-I.2      Concentrations of Gamma Emitters in Groundwater Samples Collected in the Vicinity of Zion Nuclear Power Station, 2012.

Table B-I.3      Concentrations of Iron-55 and Nickel-63 in Groundwater Samples Collected in the Vicinity of Zion Nuclear Power Station, 2012.

Table B-II.1      Concentrations of Tritium in Surface Water Samples Collected in the Vicinity of Zion Nuclear Power Station, 2012.

Table B-II.2      Concentrations of Gamma Emitters in Surface Water Samples Collected in the Vicinity of Zion Nuclear Power Station, 2012.

## 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 Zion Nuclear Power Station. This is the seventh in a series of annual reports on the status of the Radiological Groundwater Protection Program (RGPP) conducted at Zion Nuclear Power Station. This report covers both groundwater and surface water samples, collected from the environment, on station property in 2012. During that time period, 348 analyses were performed on 48 samples from 12 locations. Phase 1 of the monitoring was part of a comprehensive study initiated by Exelon to determine whether groundwater or surface water at and in the vicinity of Zion Nuclear Power Station had been adversely impacted by any releases of radionuclides. Phase 1 was conducted by Conestoga Rovers and Associates (CRA) and the conclusions were made available to state and federal regulators as well as the public in station specific reports.

Phase 2 of the RGPP was conducted by *ZionSolutions* (Exelon was responsible for the program up to 8/31/2010; *ZionSolutions* became the licensee on 9/1/2010, thus assuming responsibility for the RGPP) personnel to initiate follow up of Phase 1 and begin long-term monitoring at groundwater and surface water locations selected during Phase 1. All analytical results from Phase 2 monitoring are reported herein.

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

Gamma-emitting radionuclides were not detected at concentrations greater than their respective Lower Limits of Detection (LLDs) as specified in the Offsite Dose Calculation Manual (ODCM) in any of the groundwater or surface water samples.

Strontium-90 was not detected in any of the samples analyzed in 2012.

Tritium was not detected in any of the groundwater or surface water samples analyzed in 2012. In the case of tritium, *ZionSolutions* specified that it's laboratories achieve a lower limit of detection 10 times lower than that required by federal regulation.

Gross Alpha and Gross Beta analyses in the dissolved and suspended fractions were performed on groundwater samples during all four quarters of sampling in 2012. Gross Alpha (dissolved) was not detected in any of the groundwater locations. Gross Alpha (suspended) was not detected in any of the groundwater locations. Gross Beta (dissolved) was detected at all thirty-six groundwater

locations. The concentrations ranged from 2.6 to 21.4 pCi/L. Gross Beta (suspended) was not detected in any of the groundwater locations.

Iron-55 and Nickel-63 analyses were performed in 2012 on 36 samples from 9 locations. All results were less than their respective LLDs.

## II. Introduction

The Zion Nuclear Power Station (ZNPS), consisting of two 1,100 MWt pressurized water reactor was owned and operated by Exelon Corporation, is located in Zion, Illinois adjacent to Lake Michigan. Unit No. 1 went critical in December 1973. Unit No. 2 went critical in September 1974. The plant permanently ceased operation in January of 1998 and has been permanently defueled. The site is located in northeast Illinois on the western shore of Lake Michigan, approximately 50 miles north of Chicago, Illinois.

This report covers those analyses performed by Teledyne Brown Engineering (TBE) and Environmental Inc. (Midwest Labs) on samples collected in 2012.

### 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 Zion Nuclear 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 Conestoga Rovers and Associates (CRA) and the results and conclusions were made available to state and federal regulators as well as the public in station specific reports.

2. The Zion Nuclear 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. Zion Nuclear Power Station will continue to perform routine sampling and radiological analysis of water from selected locations.
4. Zion Nuclear 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. Zion Nuclear 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, Appendix A.

Groundwater and Surface Water

Samples of water are collected, managed, transported and analyzed in accordance with approved procedures following EPA methods. Groundwater samples were 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, industry cross-check programs, as well as nuclear industry audits. Station personnel review and evaluate all analytical data deliverables as data are received.

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 ( $^3\text{He}$ ). 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 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 to analyze the environmental samples for radioactivity for the Zion Nuclear Power Station RGPP in 2012.

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.
3. Concentrations of tritium in groundwater and surface water.
4. Concentration of gross alpha and gross beta in groundwater.
5. Concentrations of Iron-55 in groundwater.
6. Concentrations of Nickel-63 in groundwater.

B. Data Interpretation

The radiological data collected prior to Zion Nuclear Power Station becoming operational were used as a baseline with which these operational data were compared. For the purpose of this report, Zion Nuclear 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. ZionSolutions 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. ZionSolutions reports the TPU by following the result with plus or minus  $\pm$  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.

### 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, and foodstuffs. The results of the monitoring were detailed in the report entitled, Environmental Radiological Monitoring for Zion Nuclear Power Station, Commonwealth Edison Company, Annual Report 1973, issued May 1974.

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

Tritium levels in Lake Michigan water were studied in the vicinity of Zion Station throughout 1970. The concentration of tritium in the surface water samples from the Lake at Zion ranged from approximately  $311 \pm 20$  pCi/L to  $374 \pm 34$  pCi/L and averaged 340 pCi/L. There was no statistical difference in average tritium concentrations among the stations (eight stations from Kenosha to Waukegan).

Prior to 1998, surface water samples were collected at the following six locations along Lake Michigan:

- Kenosha, Wisconsin (intake located 10 miles north of the station)
- Lake County Public Water District (intake located 1.1 miles north of the Station)
- Waukegan, Illinois (intake located 6 miles south of the Station)
- North Chicago, Illinois (intake located 10 miles south of the Station)
- Great Lakes NTS (intake located 13 miles south of the Station)
- Lake Forest, Illinois (intake located 16.5 miles south of the Station)

After 1998, surface water samples were collected at the following four locations along Lake Michigan:

- Kenosha, Wisconsin (intake located 10 miles north of the station)
- Lake County Public Water District (intake located 1.1 miles north of the Station)
- Waukegan, Illinois (intake located 6 miles south of the Station)
- Lake Forest, Illinois (intake located 16.5 miles south of the Station)



Lake Michigan surface water data are collected as part of the REMP. Tritium concentrations in surface water samples from Lake Michigan taken between 1973 and 2012 have ranged from non-detect to 660 pCi/L. Groundwater was collected from one off-site well on a quarterly basis. Gamma isotopic, radiostrontium and tritium analyses were performed on all samples. Strontium-89, strontium-90, tritium and gamma emitters were below their respective LLDs.

## 1. Background Concentrations of Tritium

The purpose of the following discussion is to summarize background measurements of tritium in various media performed by others. Additional detail may be found by consulting references (CRA 2006).

### 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. Water from previous years and decades is naturally captured in groundwater, so some well water sources today are affected by the surface water from the 1960s that were elevated in tritium.

c. Surface Water Data

Tritium concentrations are routinely measured in large surface water bodies, including Lake Michigan and the Mississippi River. Illinois surface water data were typically less than 100 pCi/L.

The USEPA RadNet surface water data typically has a reported 'Combined Standard Uncertainty' of 35 to 50 pCi/L. According to USEPA, this corresponds to a  $\pm 70$  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  $\pm 70$  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  $140 \pm 100$  pCi/L. Clearly, these sample results cannot be distinguished as different from background at this concentration.

#### IV. Results and Discussion

##### A. Groundwater and Surface Water Results

###### Groundwater and Surface Water

Samples were collected from on-site wells throughout the year in accordance with the station radiological groundwater protection program. Analytical results and anomalies are discussed below.

###### Tritium

Samples from all locations were analyzed for tritium activity (Table B–I.1, Appendix B) (Table B–II.1, Appendix B). Tritium was not detected in any of the groundwater or surface water samples analyzed. Zion Nuclear Power Station does not have any off-site wells.

###### Strontium

Strontium-90 was not detected in any of the samples analyzed in 2012.

###### Gross Alpha and Gross Beta (Dissolved and Suspended)

Gross Alpha and Gross Beta analyses in the dissolved and suspended fractions were performed on groundwater samples during all four quarters of sampling in 2012. Gross Alpha (dissolved) was not detected in any of the groundwater locations. Gross Alpha (suspended) was not detected in any of the groundwater locations. Gross Beta (dissolved) was detected at all 36 groundwater locations. The concentrations ranged from 2.6 to 21.4 pCi/L. Gross Beta (suspended) was not detected at any of the groundwater locations. Although Gross Beta was detected, this data is at or near background levels and consistent with environmental data (Table B–I.1, Appendix B).

###### Gamma Emitters

All gamma-emitting radionuclides were not detected in either groundwater or surface water samples analyzed (Table B–I.2, Appendix B) (Table B–II.1, Appendix B).

B. Drinking Water Well Survey

A drinking water well survey was conducted during the summer 2006 by CRA (CRA 2006) around the Zion Nuclear Power Station.

C. Summary of Results – Inter-Laboratory Comparison Program

Inter-Laboratory Comparison Program results for TBE and Environmental Inc. (Midwest Labs) are presented in the AREOR.

D. Leaks, Spills, and Releases

**There were no leaks, spills or releases.**

E. Trends

**There are no previously identified plumes therefore there are no trends.**

F. Investigations

**There are currently no investigations at this time.**

G. Actions Taken

1. Compensatory Actions

**There have been no station events requiring compensatory actions at the Zion Nuclear Power Station.**

2. Installation of Monitoring Wells

**No new wells were required to be installed.**

3. Actions to Recover/Reverse Plumes

**There have been no station events requiring actions to recover/reverse any plumes.**

**APPENDIX A**

**LOCATION & DIRECTION**

TABLE A-1: Sampling Locations and Distance for the Radiological Groundwater Protection Program, Zion Station, 2012.

Site	Site Type	Temporary/Permanent	Distance
MW-ZN-01S	Monitoring Well	Permanent	On-Site
MW-ZN-02S	Monitoring Well	Permanent	On-Site
MW-ZN-03S	Monitoring Well	Permanent	On-Site
MW-ZN-04S	Monitoring Well	Permanent	On-Site
MW-ZN-05S	Monitoring Well	Permanent	On-Site
MW-ZN-06S	Monitoring Well	Permanent	On-Site
MW-ZN-07S	Monitoring Well	Permanent	On-Site
MW-ZN-08S	Monitoring Well	Permanent	On-Site
MW-ZN-09S	Monitoring Well	Permanent	On-Site
MW-ZN-10S	Monitoring Well	Permanent	On-Site
MW-ZN-11S	Monitoring Well	Permanent	On-Site
SW-ZN-01	Surface Water	Lake Michigan	On-Site

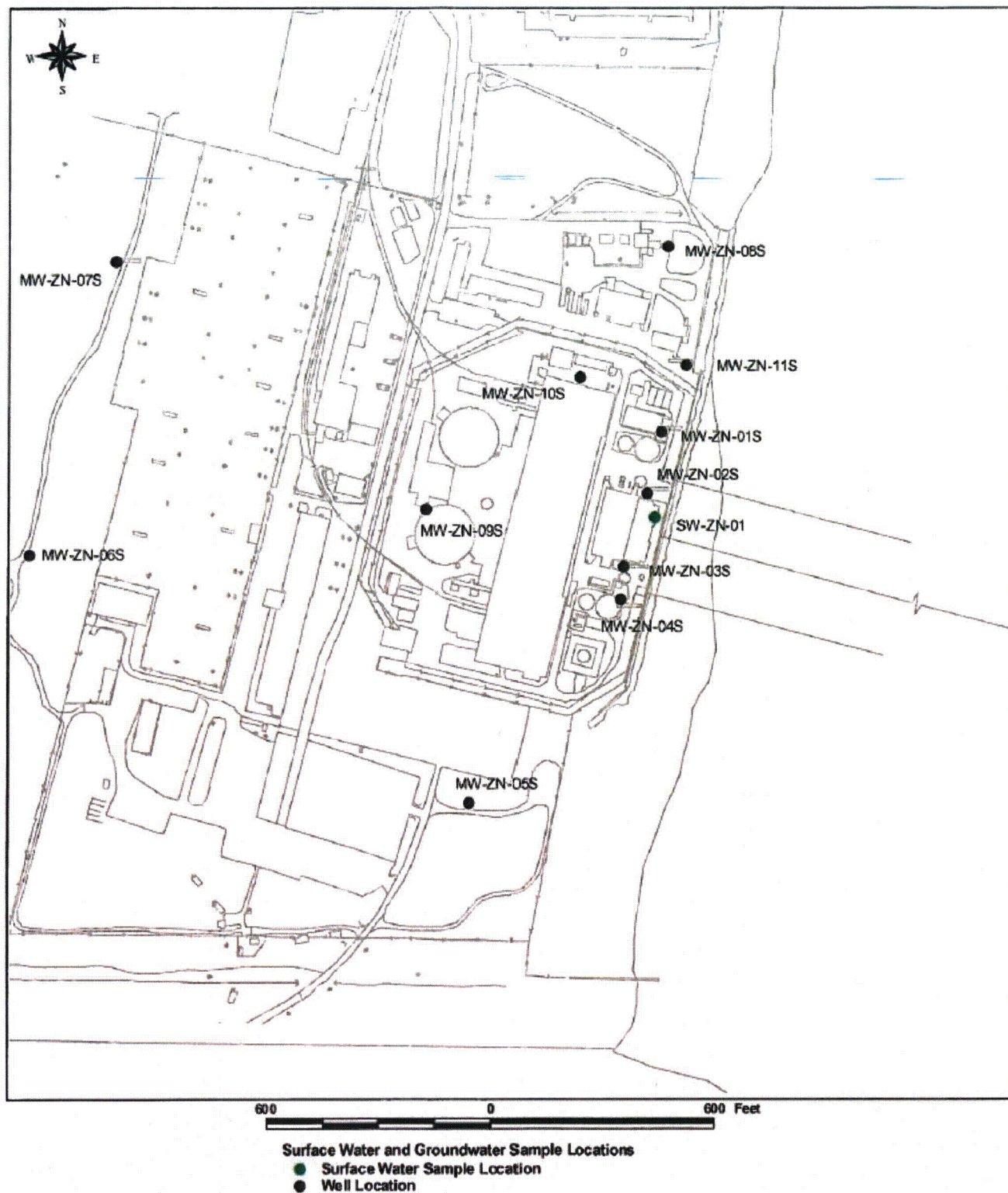


Figure A-1

Radiological Ground Water Protection Program  
Groundwater and Surface Water Locations of the Zion Station, 2012

## **APPENDIX B**

### **DATA TABLES**



**TABLE B-I.1 CONCENTRATIONS OF TRITIUM IN GROUNDWATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

COLLECTION							
SITE	DATE	H-3	Sr-90	Gr-A (DIS)	Gr-A (SUS)	Gr-B (DIS)	Gr-B (SUS)
MW-ZN-01S	02/14/12	< 173	< 0.7	< 1.1	< 0.6	8.6 ± 1.4	< 1.7
MW-ZN-01S	06/07/12	< 157	< 0.7	< 1.0	< 0.4	7.7 ± 1.3	< 1.4
MW-ZN-01S	09/18/12	< 173	< 0.7	< 1.3	< 1.3	8.5 ± 1.4	< 1.8
MW-ZN-01S	10/01/12	< 197	< 0.4	< 1.3	< 0.9	8.3 ± 1.3	< 1.7
MW-ZN-02S	02/14/12	< 176	< 0.7	< 1.0	< 0.6	18.9 ± 1.7	< 1.7
MW-ZN-02S	06/07/12	< 161	< 0.7	< 0.9	< 0.4	19.6 ± 1.6	< 1.4
MW-ZN-02S	09/18/12	< 170	< 0.8	< 1.5	< 1.3	21.4 ± 1.7	< 1.7
MW-ZN-02S	10/01/12	< 192	< 0.8	< 1.2	< 0.9	19.3 ± 1.5	< 1.7
MW-ZN-03S	02/14/12	< 172	< 0.7	< 1.1	< 0.5	9.2 ± 1.5	< 1.9
MW-ZN-03S	06/07/12	< 159	< 0.7	< 1.1	< 0.4	9.1 ± 1.3	< 1.6
MW-ZN-03S	09/18/12	< 170	< 0.8	< 1.1	< 1.3	9.4 ± 1.4	< 1.8
MW-ZN-03S	10/01/12	< 193	< 0.7	< 1.3	< 0.9	9.1 ± 1.3	< 1.7
MW-ZN-04S	02/16/12	< 173	< 0.7	< 0.7	< 0.5	10.2 ± 1.5	< 1.9
MW-ZN-04S	06/07/12	< 159	< 0.8	< 0.9	< 0.4	6.7 ± 1.2	< 1.6
MW-ZN-04S	09/18/12	< 168	< 0.8	< 1.2	< 1.3	11.7 ± 1.5	< 1.7
MW-ZN-04S	10/01/12	< 191	< 0.5	< 1.4	< 0.8	11.2 ± 1.4	< 1.6
MW-ZN-05S	02/15/12	< 173	< 0.6	< 0.7	< 0.5	2.6 ± 1.2	< 1.9
MW-ZN-05S	06/08/12	< 161	< 0.7	< 1.0	< 0.4	4.3 ± 1.1	< 1.6
MW-ZN-05S	09/19/12	< 170	< 0.8	< 1.1	< 1.3	3.9 ± 1.1	< 1.7
MW-ZN-05S	10/02/12	< 193	< 0.5	< 0.7	< 0.8	4.6 ± 1.1	< 1.6
MW-ZN-06S	02/15/12	< 97					
MW-ZN-06S	06/08/12	< 171					
MW-ZN-06S	09/20/12	< 170					
MW-ZN-06S	10/02/12	< 190					
MW-ZN-07S	02/15/12	< 174					
MW-ZN-07S	06/08/12	< 168					
MW-ZN-07S	09/20/12	< 167					
MW-ZN-07S	10/02/12	< 195					
MW-ZN-08S	02/15/12	< 171	< 0.7	< 0.8	< 0.5	4.3 ± 1.4	< 1.9
MW-ZN-08S	06/08/12	< 170	< 0.7	< 1.0	< 0.4	6.0 ± 1.2	< 1.6
MW-ZN-08S	09/20/12	< 170	< 0.7	< 1.9	< 1.3	5.4 ± 1.2	< 1.7
MW-ZN-08S	10/02/12	< 189	< 0.5	< 0.7	< 0.8	5.1 ± 1.2	< 1.6
MW-ZN-09S	02/16/12	< 174	< 0.7	< 0.8	< 0.4	5.6 ± 1.2	< 2.2
MW-ZN-09S	06/07/12	< 171	< 0.7	< 0.7	< 0.5	5.4 ± 1.0	< 1.7
MW-ZN-09S	09/19/12	< 170	< 0.9	< 1.0	< 1.0	8.7 ± 1.3	< 1.6
MW-ZN-09S	10/03/12	< 192	< 0.5	< 1.1	< 0.7	9.1 ± 1.3	< 1.6
MW-ZN-10S	02/16/12	< 175	< 0.6	< 1.0	< 0.4	7.2 ± 1.4	< 2.2
MW-ZN-10S	06/07/12	< 170	< 0.8	< 0.9	< 0.5	8.4 ± 1.3	< 1.7
MW-ZN-10S	09/19/12	< 194	< 0.9	< 0.9	< 1.0	8.4 ± 1.3	< 1.6
MW-ZN-10S	10/01/12	< 187	< 0.8	< 1.1	< 0.7	6.7 ± 1.1	< 1.6
MW-ZN-11S	02/15/12	< 182	< 0.8	< 1.1	< 0.4	9.7 ± 1.5	< 2.2
MW-ZN-11S	06/08/12	< 170	< 0.8	< 0.9	< 0.5	7.7 ± 1.2	< 1.7
MW-ZN-11S	09/19/12	< 173	< 0.7	< 1.4	< 1.0	7.9 ± 1.3	< 1.6
MW-ZN-11S	10/02/12	< 191	< 0.5	< 1.3	< 0.7	8.4 ± 1.3	< 1.6

TABLE B-I.2

**CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION DATE	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
MW-ZN-01S	02/14/12	< 46	< 66	< 4	< 4	< 10	< 4	< 8	< 5	< 8	< 4	< 4	< 45	< 11
MW-ZN-01S	06/07/12	< 69	< 119	< 6	< 6	< 14	< 7	< 12	< 7	< 11	< 7	< 6	< 46	< 17
MW-ZN-01S	09/18/12	< 42	< 87	< 4	< 5	< 12	< 4	< 10	< 5	< 10	< 5	< 5	< 36	< 10
MW-ZN-01S	10/01/12	< 59	< 55	< 5	< 5	< 12	< 6	< 14	< 8	< 13	< 5	< 5	< 48	< 13
MW-ZN-02S	02/14/12	< 44	< 37	< 4	< 5	< 10	< 5	< 9	< 5	< 8	< 4	< 4	< 41	< 11
MW-ZN-02S	06/07/12	< 60	< 67	< 8	< 7	< 14	< 8	< 16	< 7	< 12	< 8	< 7	< 50	< 14
MW-ZN-02S	09/18/12	< 48	< 41	< 5	< 5	< 12	< 5	< 10	< 5	< 10	< 5	< 5	< 41	< 12
MW-ZN-02S	10/01/12	< 70	< 79	< 9	< 10	< 13	< 10	< 11	< 10	< 13	< 8	< 6	< 64	< 16
MW-ZN-03S	02/14/12	< 37	< 79	< 4	< 4	< 9	< 4	< 7	< 5	< 8	< 3	< 4	< 39	< 11
MW-ZN-03S	06/07/12	< 47	< 56	< 6	< 5	< 10	< 6	< 13	< 6	< 11	< 6	< 8	< 32	< 15
MW-ZN-03S	09/18/12	< 57	< 48	< 5	< 6	< 13	< 5	< 9	< 5	< 12	< 5	< 6	< 40	< 12
MW-ZN-03S	10/01/12	< 80	< 79	< 6	< 7	< 16	< 7	< 17	< 9	< 15	< 7	< 6	< 57	< 21
MW-ZN-04S	02/16/12	< 38	< 37	< 3	< 5	< 8	< 4	< 6	< 5	< 8	< 3	< 4	< 34	< 11
MW-ZN-04S	06/07/12	< 81	< 200	< 8	< 9	< 19	< 12	< 17	< 8	< 12	< 6	< 9	< 52	< 18
MW-ZN-04S	09/18/12	< 59	< 59	< 5	< 5	< 12	< 4	< 9	< 7	< 10	< 5	< 5	< 42	< 14
MW-ZN-04S	10/01/12	< 57	< 119	< 7	< 6	< 18	< 6	< 11	< 7	< 11	< 7	< 8	< 51	< 19
MW-ZN-05S	02/15/12	< 38	< 75	< 4	< 4	< 9	< 3	< 8	< 4	< 7	< 3	< 4	< 36	< 10
MW-ZN-05S	06/08/12	< 48	< 114	< 5	< 5	< 11	< 5	< 10	< 6	< 9	< 5	< 6	< 32	< 10
MW-ZN-05S	09/19/12	< 65	< 154	< 6	< 6	< 16	< 7	< 14	< 9	< 16	< 8	< 8	< 53	< 16
MW-ZN-05S	10/02/12	< 90	< 66	< 10	< 9	< 24	< 9	< 19	< 10	< 19	< 8	< 10	< 64	< 23
MW-ZN-06S	02/15/12	< 47	< 94	< 4	< 5	< 12	< 5	< 10	< 5	< 10	< 4	< 5	< 46	< 12
MW-ZN-06S	06/08/12	< 57	< 47	< 6	< 6	< 12	< 6	< 13	< 7	< 13	< 5	< 6	< 33	< 10
MW-ZN-06S	09/20/12	< 67	< 67	< 6	< 8	< 16	< 7	< 14	< 8	< 11	< 5	< 6	< 48	< 11
MW-ZN-06S	10/02/12	< 69	< 117	< 7	< 7	< 14	< 7	< 17	< 8	< 12	< 6	< 7	< 47	< 17
MW-ZN-07S	02/15/12	< 38	< 69	< 4	< 4	< 9	< 4	< 8	< 4	< 9	< 3	< 4	< 41	< 10
MW-ZN-07S	06/08/12	< 50	< 111	< 5	< 6	< 16	< 6	< 8	< 6	< 11	< 7	< 5	< 31	< 13
MW-ZN-07S	09/20/12	< 60	< 106	< 5	< 8	< 12	< 5	< 12	< 7	< 9	< 5	< 6	< 43	< 12
MW-ZN-07S	10/02/12	< 66	< 57	< 5	< 7	< 13	< 7	< 13	< 7	< 14	< 6	< 7	< 38	< 13
MW-ZN-08S	02/15/12	< 43	< 89	< 4	< 5	< 11	< 4	< 9	< 5	< 8	< 4	< 5	< 46	< 13
MW-ZN-08S	06/08/12	< 57	< 49	< 5	< 6	< 13	< 6	< 10	< 6	< 10	< 6	< 6	< 29	< 10
MW-ZN-08S	09/20/12	< 52	< 106	< 7	< 5	< 15	< 7	< 10	< 7	< 10	< 5	< 6	< 42	< 13
MW-ZN-08S	10/02/12	< 63	< 120	< 6	< 5	< 14	< 7	< 11	< 8	< 15	< 7	< 6	< 40	< 16
MW-ZN-09S	02/16/12	< 41	< 71	< 3	< 4	< 9	< 4	< 8	< 5	< 8	< 3	< 4	< 38	< 11
MW-ZN-09S	06/07/12	< 64	< 66	< 7	< 6	< 14	< 5	< 13	< 7	< 12	< 6	< 7	< 39	< 13
MW-ZN-09S	09/19/12	< 73	< 59	< 5	< 6	< 16	< 8	< 11	< 6	< 11	< 6	< 8	< 42	< 11
MW-ZN-09S	10/03/12	< 37	< 37	< 3	< 5	< 6	< 4	< 7	< 4	< 7	< 3	< 5	< 22	< 11
MW-ZN-10S	02/16/12	< 48	< 103	< 5	< 5	< 11	< 3	< 11	< 6	< 9	< 4	< 5	< 41	< 16
MW-ZN-10S	06/07/12	< 47	< 110	< 6	< 6	< 10	< 7	< 15	< 5	< 13	< 5	< 6	< 36	< 14

TABLE B-I.2

**CONCENTRATIONS OF GAMMA EMITTERS IN GROUNDWATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION DATE	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
MW-ZN-10S	09/19/12	< 58	< 67	< 7	< 7	< 15	< 6	< 14	< 8	< 11	< 6	< 8	< 42	< 15
MW-ZN-10S	10/01/12	< 70	< 118	< 7	< 7	< 15	< 8	< 13	< 9	< 13	< 8	< 7	< 49	< 16
MW-ZN-11S	02/15/12	< 43	< 39	< 4	< 5	< 10	< 4	< 9	< 5	< 7	< 4	< 4	< 42	< 11
MW-ZN-11S	06/08/12	< 46	< 67	< 4	< 5	< 7	< 5	< 8	< 5	< 9	< 5	< 4	< 27	< 9
MW-ZN-11S	09/19/12	< 75	< 55	< 7	< 8	< 15	< 7	< 17	< 9	< 17	< 8	< 9	< 54	< 21
MW-ZN-11S	10/02/12	< 71	< 133	< 6	< 7	< 13	< 6	< 14	< 8	< 12	< 6	< 6	< 48	< 17

TABLE B-I.3

**CONCENTRATIONS OF IRON-55 AND NICKEL-63 IN GROUNDWATER SAMPL  
COLLECTED IN THE VICINITY OF ZION NUCLEAR STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION DATE	Fe-55	Ni-63
MW-ZN-01S	02/14/12	< 182	< 4.1
MW-ZN-01S	06/07/12	< 64	< 3.5
MW-ZN-01S	09/18/12	< 66	< 4.1
MW-ZN-01S	10/01/12	< 95	< 3.7
MW-ZN-02S	02/14/12	< 126	< 3.9
MW-ZN-02S	06/07/12	< 73	< 3.6
MW-ZN-02S	09/18/12	< 110	< 4.0
MW-ZN-02S	10/01/12	< 105	< 4.0
MW-ZN-03S	02/14/12	< 200	< 4.1
MW-ZN-03S	06/07/12	< 112	< 3.8
MW-ZN-03S	09/18/12	< 111	< 4.1
MW-ZN-03S	10/01/12	< 78	< 4.0
MW-ZN-04S	02/16/12	< 140	< 4.2
MW-ZN-04S	06/07/12	< 58	< 3.7
MW-ZN-04S	09/18/12	< 65	< 4.3
MW-ZN-04S	10/01/12	< 91	< 4.4
MW-ZN-05S	02/15/12	< 145	< 4.3
MW-ZN-05S	06/08/12	< 94	< 4.0
MW-ZN-05S	09/19/12	< 145	< 4.2
MW-ZN-05S	10/02/12	< 81	< 3.9
MW-ZN-08S	02/15/12	< 197	< 4.0
MW-ZN-08S	06/08/12	< 29	< 3.7
MW-ZN-08S	09/20/12	< 146	< 4.0
MW-ZN-08S	10/02/12	< 155	< 4.0
MW-ZN-09S	02/16/12	< 71	< 3.7
MW-ZN-09S	06/07/12	< 152	< 3.5
MW-ZN-09S	09/19/12	< 64	< 4.1
MW-ZN-09S	10/03/12	< 108	< 4.0
MW-ZN-10S	02/16/12	< 158	< 3.8
MW-ZN-10S	06/07/12	< 81	< 3.6
MW-ZN-10S	09/19/12	< 81	< 3.9
MW-ZN-10S	10/01/12	< 127	< 4.1
MW-ZN-11S	02/15/12	< 131	< 3.9
MW-ZN-11S	06/08/12	< 98	< 3.8
MW-ZN-11S	09/19/12	< 88	< 4.0
MW-ZN-11S	10/02/12	< 76	< 4.1

**TABLE B-II.1 CONCENTRATIONS OF TRITIUM IN SURFACE WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR POWER STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION DATE	H-3
SW-ZN-01	02/15/12	< 184
SW-ZN-01	06/07/12	< 175
SW-ZN-01	09/18/12	< 171
SW-ZN-01	10/01/12	< 193

TABLE B-II.2

**CONCENTRATIONS OF GAMMA EMITTERS IN SURFACE WATER SAMPLES  
COLLECTED IN THE VICINITY OF ZION NUCLEAR STATION, 2012**

RESULTS IN UNITS OF PCI/LITER  $\pm$  2 SIGMA

SITE	COLLECTION DATE	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-ZN-01	02/15/12	< 26	< 51	< 2	< 3	< 7	< 3	< 5	< 3	< 5	< 2	< 3	< 27	< 9
SW-ZN-01	06/07/12	< 57	< 95	< 5	< 6	< 10	< 9	< 10	< 7	< 9	< 6	< 6	< 40	< 14
SW-ZN-01	09/18/12	< 80	< 128	< 10	< 9	< 19	< 6	< 15	< 10	< 15	< 7	< 9	< 59	< 24
SW-ZN-01	10/01/12	< 47	< 86	< 4	< 5	< 13	< 6	< 9	< 5	< 10	< 5	< 4	< 36	< 12