
Attachment 1 to PLA-7165

**2013 Annual Radiological Environmental
Operating Report**

Susquehanna Steam Electric Station

Units 1 & 2

2013 ANNUAL REPORT

Annual
Radiological
Environmental
Operating
Report



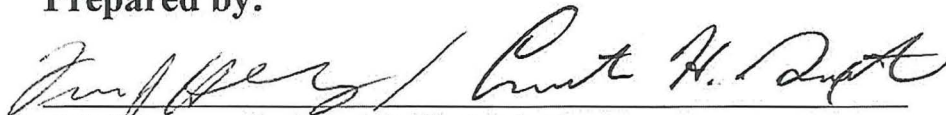
PPL Susquehanna, LLC
Berwick, PA
April 2014

**SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 and 2**

**Annual Radiological
Environmental Operating Report**

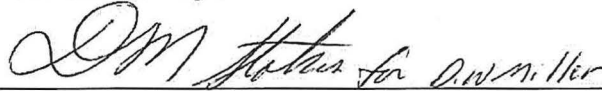
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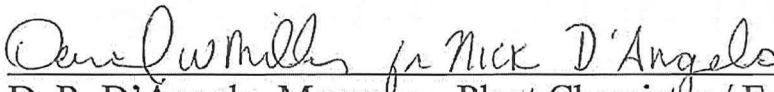
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I. Summary

During normal operations of a nuclear power generating station there are permitted releases of small amounts of radioactive material to the environment. To monitor and determine the effects of these releases a Radiological Environmental Monitoring Program (REMP) has been established around the Susquehanna Steam Electric Station (SSES). The results of the REMP are published annually, providing a summary and interpretation of the data collected.

Ecology III was responsible for the collection of environmental samples during 2013. Teledyne Brown Engineering (TBE) was responsible for the analysis of environmental samples during 2013. The results are discussed in this report. Landauer provided the dosimetry services for SSES during 2013.

This Annual Radiological Environmental Operating Report (AREOR) conducted for SSES covers the period January 1, 2013 through December 31, 2013. During that time period, 1373 analyses were performed on 1125 samples.

Of the two man-made radionuclides (tritium [H-3] and cesium-137 [Cs-137]) detected in the environment by the Susquehanna Steam Electric Station (SSES) Radiological Environmental Monitoring Program (REMP), tritium is the only radionuclide attributable to SSES operation. The whole body and organ dose to members of the public attributable to tritium identified in REMP cooling tower blowdown samples was $7.27E-04$ mRem. Tritium was included in the dose calculation because it was identified in the REMP samples of water being discharged to the Susquehanna River. The 2013 average concentration of tritium in the cooling tower blowdown water and the 2013 average cooling tower blowdown flow were used to determine the amount of tritium released. The presumed exposure pathways to the public from this radionuclide were drinking water taken from the Susquehanna River at

Danville, PA and eating fish caught near the SSES discharge to the river. Dose from ground plane deposition (shoreline exposure) is not applicable because tritium does not emit gamma radiation and the beta radiation emitted by tritium is not sufficiently penetrating to reach an individual on the shore.

Based on the above outlined methodology, the total tritium activity released from the SSES to the Susquehanna River in 2013 was 79.3 curies.

The 2013 average dilution factor for the Susquehanna River was 697, based on the annual average river flow of $8.20\text{E}+06$ gpm and the annual average cooling tower blowdown flow of $1.18\text{E}+04$ gpm.

The REMP Sample Equipment Operability and year to year trend comparison is located in Appendix E, Table E-1

The REMP was conducted in accordance with the SSES Technical Requirements Manual (TRM) and the respective station Offsite Dose Calculation Manual (ODCM) which are based on the design objectives in 10CFR Part 50 Appendix I, Sections IV.B.2, IV.B.3 and IV.C. The Lower Limit of Detection (LLD) values required by the TRM and SSES ODCM were achieved for the 2013 reporting period. The REMP objectives were also met during this period. The concentration of radioactive material in the environment that could be attributable to SSES operations was only a small fraction of the concentration of naturally occurring and man-made radioactivity. Since these results were comparable to the results obtained during the preoperational phase of the program and combined with historical results collected since commercial operation, it can be concluded that the levels and fluctuations were as expected and that the operation of the SSES had no significant radiological impact on the environment. Additionally, the REMP sample results for 2013 verify the adequacy of the SSES radioactive effluent control systems.

Samples of air particulates, air iodine, milk, groundwater, drinking water, vegetation, soil, surface water, fish and sediment were collected and analyzed. External radiation dose measurements were also made in the vicinity of SSES using passive dosimeters.

Air particulate samples were analyzed for concentrations of gross beta weekly and gamma emitting nuclides quarterly. Gross beta and cosmogenically produced beryllium-7 (Be-7) were detected at levels consistent with those detected in previous years. No fission or activation products were detected.

High sensitivity iodine-131 (I-131) analyses were performed on weekly air samples. All results were less than the minimum detectable concentration.

Environmental gamma radiation measurements were performed quarterly using Optically Stimulated Luminescent dosimeters (OSLD). The levels of radiation detected were consistent with those observed in previous years.

Cow milk samples were analyzed for concentrations of I-131 and gamma emitting nuclides. All I-131 results were below the minimum detectable concentration. Naturally occurring potassium-40 (K-40) was detected at levels consistent with those detected in previous years. No fission or activation products were detected.

A one-time collection of four pasture grass samples was made from two locations in 2013. Naturally occurring Be-7 and K-40 were detected in the four samples at concentrations ranging from 650 to 1,090 pCi/kg wet and 3230 to 8060 pCi/kg wet, respectively. Preoperational data is not available for comparison.

Groundwater samples were analyzed for concentrations of tritium and gamma emitting nuclides. Tritium activities detected were consistent with

those detected in previous years. No fission or activation products were detected.

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

Food product (fruits, vegetables and broadleaf vegetation) samples were analyzed for concentrations of gamma emitting nuclides. Naturally occurring potassium-40 was detected at levels consistent with those detected in previous years. No fission or activation products were detected.

Soil samples were analyzed for concentrations of gamma emitting nuclides. In addition to the naturally occurring isotopes (i.e. K-40, thorium-228 [Th-228], radium-226 [Ra-226] and actinium-228 [Ac-228]), Cs-137 was detected in one of the soil samples. The sample data is consistent with historical and preoperational data which indicates that the presence of Cs-137 in the soil is due to residual fallout from atmospheric nuclear weapons testing in the 1970s and early 1980s and the Chernobyl event.

Surface water samples were analyzed for concentrations of tritium and gamma emitting nuclides. Tritium activities detected were consistent with those detected in previous years. No fission or activation products were detected.

Fish and shoreline sediment samples were analyzed for concentrations of gamma emitting nuclides. No fission or activation products were detected in fish or sediment samples.

II. The Radiological Environmental Monitoring Program

The SSES is located on approximately a 1500 acre tract along the Susquehanna River, five miles northeast of Berwick in Salem Township, Luzerne County, Pennsylvania. The area around the site is primarily rural, consisting predominately of forest and agricultural lands.

The station consists of two boiling water reactor generating units. Each unit has completed an Extended Power Uprate process which has increased licensed thermal power from 3489 MWt (megawatt thermal) to 3952 MWt. Unit-1 completed the power uprate in 2010 and Unit 2 completed the power uprate in 2011.

More specific information on the demography, hydrology, meteorology, and land use characteristics of the area in the vicinity of the SSES can be found in the Environmental Report [Reference 1], the Final Safety Analysis Report [Reference 2] and the Final Environmental Statement [Reference 3] for the SSES.

Radioanalytical data from samples collected under the REMP were compared with results from the preoperational phase and historical results during operations. Differences between these periods were examined statistically to determine the effects of station operations. This report presents the results from January 1 through December 31, 2013, for the SSES Radiological Environmental Monitoring Program (REMP).

A. Objectives of the Operational REMP

The objectives of the Operational REMP are to:

1. Document compliance with SSES REMP Technical Requirements and radiological environmental surveillances.

2. Verify proper implementation of SSES radiological effluent controls.
3. Identify, measure and evaluate trends of radionuclide concentrations in environmental pathways near SSES.
4. Assess impact of SSES Effluents on the Environment and the public.
5. To verify that SSES operations have no detrimental effects on the health and safety of the public or on the environment.

B. Implementation of the Objectives

1. In order to meet the objectives, an operational REMP was developed. Samples of various media were selected for monitoring due to the radiological dose impact to humans and other organisms. The selection of samples was based on:
 - (a) Established critical pathways for the transfer of radionuclides through the environment to man, and
 - (b) Experience gained during the preoperational phase. Sampling locations were determined based on site meteorology, Susquehanna River hydrology, local demography, and land uses.
2. Sampling locations were divided into two classes, indicator and control. Indicator locations are sited where it is expected that radiation and radioactive material that might originate from the station would be detectable. Control locations are selected in areas where they would be unaffected by station operations (i.e. Susquehanna River upstream from the station, >10 miles from the station in least prevalent wind directions). Fluctuations

in the levels of radionuclides and direct radiation at indicator locations are evaluated with respect to analogous fluctuations at control locations. Indicator and control location data are also evaluated relative to preoperational data.

3. Appendix A, Summary of Data for SSES, describes and summarizes the analytical results in accordance with the SSES Technical Specifications.
4. Appendix B, Location, Designation, Distance, Direction and Sample Collections and Analytical Methods, describes the coding system which identifies sample type and location. Table B-1 lists the location codes, locations, latitude, longitude, and the types of samples collected at each location. Table B-2 contains sample medium, analysis and sampling details.
5. The sampling locations are indicated on the following maps:
 - Map B-1, Direct Radiation Monitoring Locations Within One Mile
 - Map B-2, Direct Radiation Monitoring Locations From One to Five Miles
 - Map B-3, Direct Radiation Monitoring Locations Greater Than Five Miles
 - Map B-4, Environmental Sampling Locations Within One Mile
 - Map B-5, Environmental Sampling Locations From One to Five Miles
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III. Program Description

A. Data Interpretation

Results of analyses are grouped according to sample type and presented in Appendix C, Data Tables. All results above the Lower Limit of Detection (LLD) are at a confidence level of ± 2 sigma. This represents the range of values into which 95% of repeated analyses of the same sample should fall. As defined in U.S. Nuclear Regulatory Commission Regulatory Guide 4.8, LLD is the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability, with only 5% probability of falsely concluding that a blank observation represents a "real signal". LLD is normally calculated as 4.66 times the standard deviation of the background counting rate, or of the blank sample count, as appropriate, divided by counting efficiency, sample size, 2.22 (dpm per picocurie), the radiochemical yield when applicable, the radioactive decay constant and the elapsed time between sample collection and time of counting. The LLD is an "a priori" number which represents the capability of the measurement system.

The Minimum Detectable Concentration (MDC) is defined as the smallest concentration of radioactive material that can be detected at a given confidence level. The MDC differs from the LLD in that the MDC takes into consideration the interference caused by the presence of other nuclides while the LLD does not. The MDC is an "a posteriori" number which is an indicator of the performance of the measurement system. The MDC is set to be below the LLD.

The grouped data were averaged and standard deviations calculated. Thus, the ± 2 sigma deviations of the averaged data represent sample

and not analytical variability. For reporting and calculation of averages, any result occurring at or below the LLD is considered to be at that level.

B. Program Exceptions

Date	Sample Type	Location	Exception	Corrective Action
01/16/13 to 01/23/13	AP/C	6G1	Timer box malfunction – digits failed to advance properly. No effect on continuous sampler operation for sample period.	01/23/13: Timer box reset and proper advancement of digits confirmed. Operability verified.
01/23/13 to 01/30/13	AP/C	6G1	Timer box malfunction – digits failed to advance properly. No effect on continuous sampler operation for sample period.	01/30/13: Timer box reset and proper advancement of digits confirmed. Operability verified.
01/23/13 to 01/30/13 TRO 3.11.4.1 Condition A	AP/C	3S2	Power outage for approximately 3.4 hours (time unknown) as determined by timer box reading, resulting in non-continuous operation for sample period.	AR – 1665918 01/30/13: No corrective action required. Air monitor resumed normal operation when power was restored. Operability verified.
01/29/13 to 02/05/13 TRO 3.11.4.1 Condition A	Surface Water	6S6	No sample flow through ACS. Non-representative sample for sample period.	AR – 1667862 02/05/13: Grab sample collected at alternate location 5S9 as per procedure for week 2. 02/08/13: Maintenance performed. ACS restored to service @ 1417 hours, resulting in delayed start for week 3. 02/12/13: Operability verified. Valid sample collected for week 3.
02/06/13 to 02/13/13 TRO 3.11.4.1 Condition A	AP/C	3S2 13S6 13S6Q	Power outage for approximately 48 minutes (date/time unknown) as determined by timer box reading, resulting in non-continuous operation for sample period.	AR – 1669609 02/11/13: No corrective action required. Air monitors resumed normal operation when power was restored. Operability restored.
1 st Quarter 2013 02/26/13	Ground-water	MW-6 (13S7)	Quarterly groundwater (well) sample was not collected within quarterly time limit due to cooling tower falling ice hazard.	AR – 1681886 03/19/13: Obtain sample when conditions permit. 04/11/13: 1 st quarter sample collected.

Date	Sample Type	Location	Exception	Corrective Action
03/27/13 to 04/03/13	AP/C	6G1	Timer box malfunction – digits failed to advance properly. No effect on continuous sampler operation for sample period.	04/03/13: Time box replaced. Operability verified.
04/10/13 to 04/24/13	AP/C	6G1	Planned electrical maintenance from 04/15/13 @ 0830 to 04/19/13 @ 1230, resulting in non-continuous operation for the sample period. Pre-notification by PPL Electric Utilities. NOTE: TRM requirements were met since the other control location (8G1) was operational during planned power outage.	AR – 1689822 04/17/13: Air monitor not operational due to planned power outage. Low sample volume for sample period 04/10/13 to 04/17/13. 04/24/13: Operability verified.
04/17/13 to 04/24/13	AP/C	6G1	Timer box malfunction – digits failed to advance properly. No effect on continuous sampler operation for sample period.	04/24/13: Time box replaced. Operability verified.
04/24/13 to 05/01/13	AP/C	8G1	Power outage of approximately 4.9 hours (date/time unknown) as determined by timer box, resulting in non-continuous operation for sample period. NOTE: TRM requirements were met since the other control location (6G1) was operational.	AR – 1698761 No corrective action needed. Air monitor resumed normal operation when power was restored. 05/01/13: Operability verified.
05/15/13 to 05/22/13	AP/C	8G1	Power outage of approximately 1.3 hours (date/time unknown) as determined by timer box, resulting in non-continuous operation for sample period.	AR – 1707282 No corrective action needed. Air monitor resumed normal operation when power was restored. 05/22/13: Operability verified.
05/15/13 to 05/22/13	AP/C	6G1	Power outage of approximately 5.3 hours (date/time unknown) as determined by timer box, resulting in non-continuous operation for sample period. After further investigation, sample collectors found power strip to air monitor in off position (cause unknown). Delayed start time of 1 hour 15 minutes for next sample period.	AR – 1707282 Power strip turned on and power restored. Operability verified.

Date	Sample Type	Location	Exception	Corrective Action
06/13/13 TRO 3.11.4.1 Condition F	Milk	10D3	Required indicator milk sample unavailable. Drasher Farm sold cows on 05/22/13 due to financial reasons.	AR – 1712214 The following samples were collected to meet TRM requirements: Pasture grass (vegetation) from location 10D3 and control location 10G1 for biweekly scheduled milk samples on 06/17/13 and 07/01/13; broadleaf vegetation from indicator location 8G1 (Pumpkin Hill Farm) on 06/26/13 and control location 15G1 (Dancing Hen Farm) on 07/01/13. Broadleaf vegetation will continue to be sampled monthly as available.
06/05/13 to 06/12/13	AP/C	3S2 13S6 13S6Q 12S1	3S2, 13S6, 13S6Q – Power outage of 0.4 hours on 06/11/13 (time unknown) as determined by timer box, resulting in non-continuous operation for sample period 12S1- power loss of 0.2 hours.	AR – 1715499 No corrective action required. Air monitors resumed normal operation when power was restored. 06/12/13: Operability verified
07/09/13 to 07/16/13	Surface Water	2S7	Composite container overflowed resulting in non-representative sample for week 3 July composite. Reason unknown.	AR – 1727357 Grab sample collected 07/16/13 @1018 for week 3 July composite. 07/16/13: Reconfigured and recalibrated sampler according to CH-TP-087. Sampler resumed normal operation. Operability verified

Date	Sample Type	Location	Exception	Corrective Action
07/23/13 to 07/30/13	Surface Water	6S6	Diminished flow rate (<1.5 gpm) found by I&C during routine PM for week 1 August composite.	AR – 1730852 Adequate sample volume collected for week 1 August composite. Able to obtain procedural aliquot with volume setting at 50%. ACS remained operable. 09/14/13: I&C performed maintenance (PCWO-1746241) to restore flow to required 1.5 gpm. 09/17/13: Operability verified.
07/23/13 to 07/30/13	Surface Water	2S7	Interior sample delivery tubing found displaced from tube guide on the bottom of the controller assembly by E-III sample collectors during weekly sample collection. Reason unknown. No operability issues associated with this condition.	AR – 1732424 Adequate sample volume collected for week 1 August composite. Tubing reinserted into tube guide to allow sample water delivery to composite container. 07/30/13: Operability verified.
07/23/13 to 07/30/13	Surface Water	2S7	Blowdown isolated for river diving activities during week 1 August composite: 07/24/13 @ 0345-1620 07/25/13 @ 0511-1805 07/26/13 @ 0402-1000 07/29/13 @ 0840-1727 07/30/13 @ 0235-1528	No corrective action needed for blowdown isolation. Dates and times were noted on sample collection form.

Date	Sample Type	Location	Exception	Corrective Action
07/30/13 to 08/06/13	Surface Water	6S6	Diminished flow rate (<1.5 gpm) found by E-III sample collectors during weekly collection for week 2 August composite.	AR – 1733523 Adequate sample volume collected. Unable to obtain procedural aliquot with volume setting stroke hold at maximum. ACS remained operable. 09/14/13: Maintenance performed to unblock line and restore required flow rate to 1.5 gpm. 09/17/13: Operability verified.
2 nd Quarter 2013	Direct Radiation	7G1	OSL dosimeter 7G1 located in the SE sector at 14 miles from the site was found missing during the exchange of the second quarter 2013 monitoring period. This dosimeter is a redundant control dosimeter.	Corrective actions were initiated with placement of a new dosimeter at 7G1 for the third quarter 2013. Occasional vandalism is unavoidable. Actions to prevent recurrence are not applicable.
09/03/13 to 09/10/13	Surface Water	6S6	Diminished flow rate (<1.5 gpm) found by E-III sample collectors during weekly collection for week 2 September composite.	AR – 1745301 Adequate sample volume collected during sample period for week 2 September composite. Able to obtain procedural aliquot with volume setting stroke hold at 60%. ACS remained operable. 09/14/13: Maintenance performed to unblock the line and restore required flow rate to 1.5 gpm. 09/17/13: Operability verified.

Date	Sample Type	Location	Exception	Corrective Action
11/06/13 to 11/13/13	AP/C	13S6	Flow rate upon arrival at air monitor was 2.5 cfm, above procedural range of 2.0–2.4 cfm. Reason unknown. No effect on continuous sampler operation for sample period.	Flow rate adjusted to 2.2 cfm on departure. Operability verified.
11/13/13 to 11/20/13	AP/C	13S6	Timer box reading did not reflect actual sample time (166.5 vs calculated run time of 167.4 hours). Reason unknown. Calculated volume did not correspond with dry gas meter volume. Reason unknown, but possible cause could be changes in air temperature during sampling week. Both issues had no effect on continuous monitoring for sample period.	AR 2013-04531 Monitored situation to evaluate applicable corrective actions. Operability verified.
11/20/13 to 11/26/13	AP/C	13S6	Timer box malfunction. Digits failed to advance. No effect on continuous sampler operation for sample period.	Timer box replaced. Operability verified.
4 th Quarter 2013	Ground Water	MW-7 (2S8)	Sample unavailable due to insufficient ground water. Sample pump operation was verified as satisfactory and no blockages were identified in the lines.	AR 2013-04838 Will sample next quarter (February 2014). TRM required sampling at other ground water monitoring locations was conducted for 4 th quarter with no issues.
11/26/13 to 12/03/13	Surface Water	6S6	Diminished flow rate (<1.0 gpm) found by E-III sample collectors for week 1 December composite.	CR 2013-05310 Adequate sample volume collected during sample period for week 1 Dec. composite. Able to obtain procedural aliquot with volume setting at maximum. ACS remained operable. 12/06/13: Maintenance performed to unblock line and restore required flow to 1.5 gpm.

Date	Sample Type	Location	Exception	Corrective Action
12/10/13 to 12/16/13	Surface Water	6S6	Diminished flow rate (<1.0 gpm) found by E-III sample collectors for week 3 December composite.	CR 2013-06766 Adequate sample volume collected during sample period for week 3 Dec. composite. Not able to obtain procedural aliquot with volume setting at maximum. ACS remained operable.
12/16/13 to 12/31/13 TRO 3.11.4.1 Condition A	Surface Water	6S6	12/23/13: No sample flow found by E-III sample collectors for week 4 December composite. 12/31/13: No sample flow found by E-III sample collectors for week 5 December composite.	CR 2013-07175 12/23/13: Grab sample collected at location 5S9 to represent week 4 Dec. composite. 12/31/13: Grab sample collected at location 5S9 to represent week 5 Dec. composite. 12/31/13: I&C maintenance unsuccessful. CR 2013-07237 generated. 01/03/14: Maintenance performed to unblock line and restore required flow to 1.5 gpm.
12/23/13 to 12/31/13	Surface Water	2S7	12/23/13: Blowdown isolated from 0849 to 1605 hours for planned maintenance.	AR 2013-07458 Verified sampler operation. Date and time were noted on sample collection form.

Date	Sample Type	Location	Exception	Corrective Action
4 th Quarter 2013	Direct Radiation	7G1	During collection of 4 th quarter 2013 environmental dosimeters, the dosimeter at location 7G1 was missing. This dosimeter is a redundant control dosimeter.	Corrective actions were initiated with placement of a new dosimeter at 7G1 for the first quarter 2014. Occasional vandalism is unavoidable. Actions to prevent recurrence are not applicable.

2013 Totals: 4 occurrences resulted in entry into TRO 3.11.4.1 Condition A
1 occurrence resulted in entry into TRO 3.11.4.1 Condition F

All remaining occurrences were non-TRO events. Actions to prevent recurrence were not applicable to any of the occurrences in 2013.

C. Program Changes

Milk location 10D3 went out of business May 22, 2013.

Three broadleaf vegetation locations, 8C1, 10B5 and 15G1, were added to the program in 2013. Leafy vegetation is collected at these locations in lieu of milk due to the loss of the dairy farm at location 10D3.

D. Quality Assurance Program

Teledyne Brown Engineering

The quality of the results obtained by TBE is ensured by the implementation of the Quality Assurance Program as described in the Teledyne Brown Engineering Quality Assurance Manual and the Teledyne Brown Engineering Procedure Manual.

E. Summary of Results – Inter-laboratory Comparison Program

The TBE laboratory performed 185 analyses of Performance Evaluation (PE) containing spiked samples of air particulate, air