



Rensselaer

DEPARTMENT OF MECHANICAL,
AEROSPACE, AND NUCLEAR ENGINEERING

RCF 20-01
February 20, 2020

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

NRC License CX-22, Docket Number 50-225.

Reference: NRC letter "Rensselaer Polytechnic Institute - Supplemental Information Needed for Acceptance of the Application for a License Amendment Re Modification to the Restricted and Exclusion Areas for the Renewed Facility License No. CX-22 (EPID: L-2019-LLA-0254)", ADAMS Accession No. ML19340C076, dated December 10, 2019

Xiaosong Yin, Project Manager:

This letter submits supplemental information to address the four (4) questions presented in the above referenced letter. Response to these questions were prepared with inputs from the Office of Environmental, Health, Safety and Risk Management, the Office of Physical Plant, and the School of Engineering Dean's Office at Rensselaer Polytechnic Institute.

Sincerely,

A handwritten signature in dark ink, appearing to read "Wei Ji".

Dr. Wei Ji, Facility Director
School of Engineering
Rensselaer Polytechnic Institute

Attachment:

Supplemental Information Needed for Acceptance of the Application for a License Amendment Re Modification to the Restricted and Exclusion Areas for the Renewed Facility License No. CX-22

AD20
NRR

cc:

Dr. Shekhar Garde, Dean, School of Engineering

Dr. Suvranu De, Head, Department of Mechanical, Aerospace, and Nuclear Engineering

Mr. Claude Rounds, Vice President, Administration

Ms. Annette Chism, Director, Environmental, Health, Safety and Risk Management

Dr. Liping Huang, Associate Dean for Research, School of Engineering

Dr. Hyun Kang, NSRB Chair

Mr. Ernest Katzwinkel, Director, Physical Plant

Dr. Manish Arha, Radiation Safety Officer

Dr. Jason Thompson, Reactor Critical Facility (RCF) Operations Supervisor

**SUPPLEMENTAL INFORMATION NEEDED FOR ACCEPTANCE OF THE
APPLICATION FOR A LICENSE AMENDMENT RE MODIFICATION TO THE
RESTRICTED AND EXCLUSION AREAS FOR THE RENEWED FACILITY LICENSE
NO. CX-22**

This supplemental information provides details requested by the NRC from RPI in a letter dated December 2019 (see Reference [1]). NRC specifically sent four questions to RPI. The following document provides answers and data in response to those four questions.

- 1) Provide a detailed description of a) what has been changed regarding the restricted and exclusion areas, not just the numerical number changes; b) the scale of the areas lost due to the construction around the facility; and c) environmental impacts for those lost areas.

A drawing prepared by Hershberg and Hershberg Consulting Engineers is attached with this document as **Appendix 1**. The drawing shows both the locations of the old fence and the locations of the new fence on the same drawing. Old fence is shown by red lines with overlaid “x” symbols. They are also labeled using text and arrows. Also shown on the drawing are the locations of the six core samples, B01 – B06. Figure 1 below shows the sample locations relative to the old fencing in a satellite image. Figure 2 superimposes the sample locations on a photograph of the new site arrangement.

The attached **Appendix 1A** “Safety Analysis of construction activities surrounding RPI RCF”. Fence Line Reconfiguration” dated September 12, 2015 prepared by Peter F. Caracappa, Certified Health Physicist and Director of the RCF (at that time) provides an Analysis of the general construction plan and activities in the area surrounding the RCF.

The attached **Appendix 1B** “Safety Analysis of Fence Line Reconfiguration” dated September 15, 2015 prepared by Peter F. Caracappa, Certified Health Physicist and Director of the RCF (at that time) provides a Description and an Analysis of the reconfiguration of the fence line boundaries surrounding the RCF.



Figure 1: Sample Locations Relative to Old Site Fencing

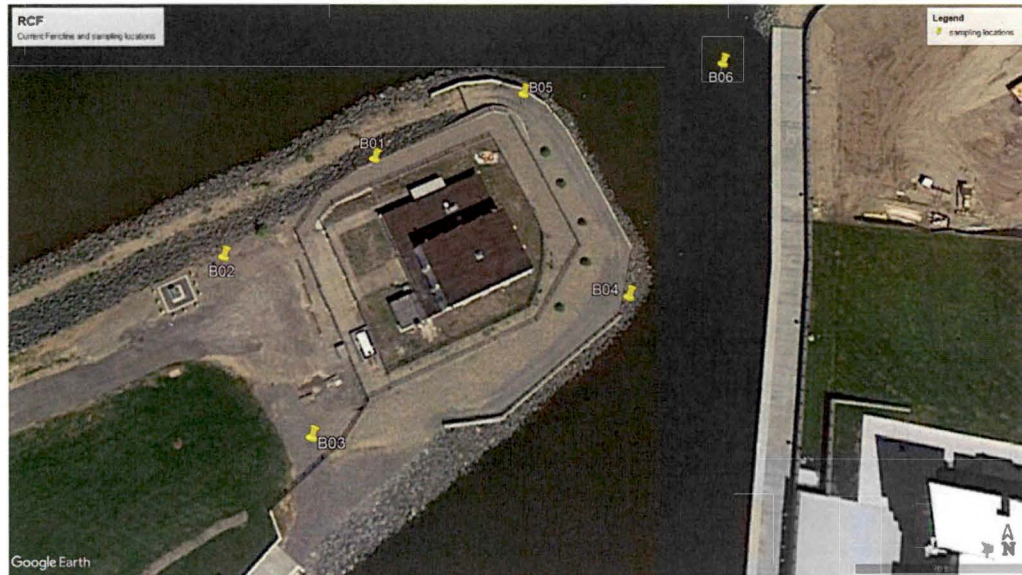


Figure 2: Sample Locations Relative to New Fencing

The results of the soil samples are presented in the following section.

- 2) Provide systematic radiological survey data, including (but not limited to) area exposure rate measurements, soil and ground water samples, etc, to support that there is no significant risk to the public and to the environment from those areas released for unrestricted use.

RPI monitors the external radiation doses with six thermoluminescent detectors (TLD) attached to the inner and outer fences. Figure 3 shows the locations of the TLDs on a schematic.

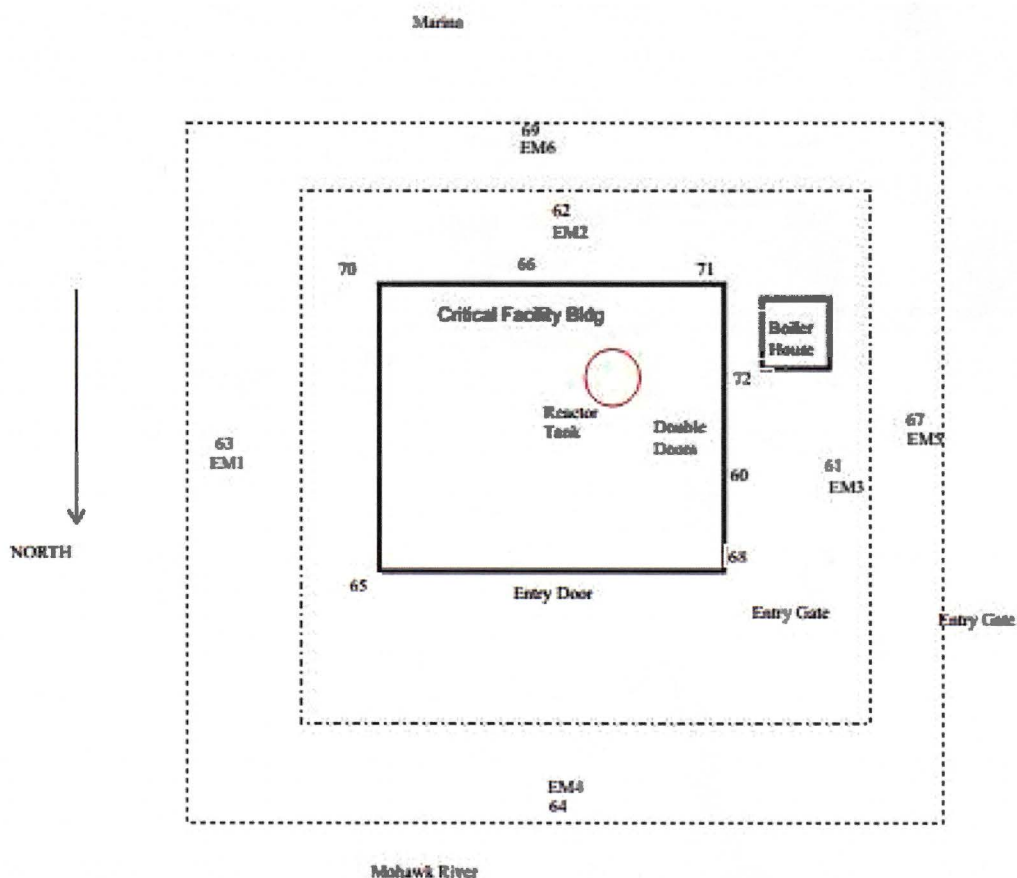


Figure 3: Exterior Survey Map

Several years of data from these TLDs is presented in Table 1. The fences were relocated in 2015. Results from EM2 and EM6 suggest a small increase in gamma radiation dose at the fences closest to the reactor. EM2 is on the inner fence located about 28 feet from the reactor. No other detector on the inner fence is closer. EM6 is on the outer fence, about 35 feet from the reactor. No other detector on the outer fence is closer.

Table 1: Exterior Environmental Monitoring Results 2011 – 2018

Annual Environment Monitoring Results, mR							Annual Integrated Power, kw-hr	Notes
Year	EM1	EM2	EM3	EM4	EM5	EM6		
2011	0	5	5	0	1	6	0.078	
2012	0	0	0	0	0	0	0.039	1
2013	0	0	0	0	0	0	0.03	
2014	0	0	0	0	0	0	0.026	
2015	0	7	0	0	0	0	0.036	2
2016	0	8	0	0	0	8	0.078	3
2017	0	6	0	0	0	5	0.11	
2018	0	0	0	0	0	0	0.006	4

NOTES:

1. Critical Reactor Laboratory course expanded from one section to three sections.
2. Year of fence relocation.
3. Critical Reactor Laboratory course reduced to two sections.
4. Final year for Critical Reactor Laboratory course.

Radiation surveys on **January 15, 2020** with the reactor operating at ten watts are recorded on Table 2 for locations shown on Figure 3.

Table 2: RCF External Survey at 10 W Operating Power

Location	Reading, mR/hr
61	0.1
62	0.4
63	0.17
64	0.02
66	1.5
67	0.09
69	0.2

Survey Instrument: Ludlum Model 3

Serial #: 233498

Calibration Date: 6/25/2019

Soil samples were collected from six locations near the Reactor Critical Facility. See attached **Appendix 2** for GPS co-ordinates of the locations. The locations of soil sample B04 and B06 were outside the exclusion area boundary. Locations of remaining soil samples, i.e., B01, B02, B03 and B05 were between the restricted area boundary and the exclusion area boundary.

The soil samples were collected from each location using a MacroCore sampler. Two samples from each location, samples "A" and "B" were collected at a depth interval of 0-8 feet and 8-16 feet respectively. The soil samples were screened for ionizing radiation. Ionizing radiation readings from the soil samples did not exceed 25 $\mu\text{R/hr}$, consistent with typical background radiation. All the samples were analyzed for gamma emitting radionuclides (listed in analytical results of **Appendix 3**) and gross alpha and beta activities. Four soil samples were also analyzed for Uranium 238 and Thorium 232. See attached **Appendix 3 and 4** for details of the analytical results and sample report.

Radionuclides were detected in each of the twelve soil samples. The concentrations of radionuclides in the samples B04 and B06 (from locations outside the exclusion boundary) were similar, within detection uncertainty, to the radionuclide concentrations detected in the samples B01, B02, B03 and B05 (from locations between restricted area boundary and exclusion area boundary). The concentrations of radionuclide tested in all the samples were consistent with those found in coal ash (a primary filler in the RPI parcel area, which is a part of surrounding brown field).

3) Provide justification for applicable impacts to your license and ability to continue to meet regulatory requirements in 10 CFR 20, special license conditions in your safety analysis report, and obligated standards in your license, including but not limited to public dose limits, accident dose estimates for your licensed maximum hypothetical accident.

Environmental monitoring results and radiation survey results presented in the previous section show that public dose limits of 10 CFR 20 are met.

Reference [2] provides accident dose and dose rate estimates for two accident scenarios, the maximum hypothetical accident and a loss of moderator accident.

The maximum hypothetical accident is a release of radioactive material from an encapsulated experiment. The release is an airborne release into the interior of the reactor building. The maximum amount of material available for release is defined by the Technical Specifications (TS). RPI calculated a maximum potential radiation dose of 0.1 mSv (10 mrem). NRC staff recalculated with more conservative assumptions and determined the maximum potential radiation dose could be 0.14 mSv (14 mrem). This is less than the 10 CFR 20.1301 limit of 1 mSv (100 mrem). Fence relocation does not affect this dose estimate since the release would be airborne and would escape the site.

The loss of moderator accident would cause radiation exposure due to the loss of the shielding that the moderator provides. The reactor would be shut down by the loss of moderator. The radiation level at the top of the reactor would be about 0.05 mSv (5 mrem) just after shutdown and then decays over time. At one week after shutdown, the dose rate would be zero. Fence relocation would increase the radiation dose rate at the exclusion area boundary and the restricted area boundary since both boundaries are closer than was the case when the accident was analyzed.

The restricted area boundary is now 28.3 feet from the reactor at its closest point. The accident dose rate estimate in Reference 2 assumed the restricted area boundary was 30 feet and the calculated dose rate was 0.001 mSv/hr (0.1 mrem/hr). For the closer restricted area boundary, the estimated dose rate increases to 0.0011 mSv/hr (0.11 mrem/hr). This is much less than the 10 CFR 20.1301 limit of 0.02 mSv/hr (2 mrem/hr).

The exclusion area boundary is now 35.4 feet from the reactor at the closest point. Dose rate estimates assumed the exclusion area boundary was 50 feet from the reactor and the dose rate estimate was calculated to be 0.0003 mSv/hr (0.03 mrem/hr). For the closer exclusion area boundary, the increased dose rate estimate is 0.0006 mSv/hr (0.06 mrem/hr). The total dose over the course of a year remains well below the annual dose limit of 1 mSv (100 mrem).

The pertinent data from the previous two paragraphs are summarized in Table 3.

Table 3: Pertinent Changes to Boundary Parameters

	Distance from Reactor, ft		Calculated Dose Rate, mSv/hr	
	Previous (assumed)	New (measured)	Previous	New
Restricted Area	30	28.3*	0.001	0.0011
Exclusion Area	50	35.4*	0.0003	0.0006

*at its closest point

4) Describe any changes made to methodologies or calculations used to justify licensed radiological limits or reporting criteria.

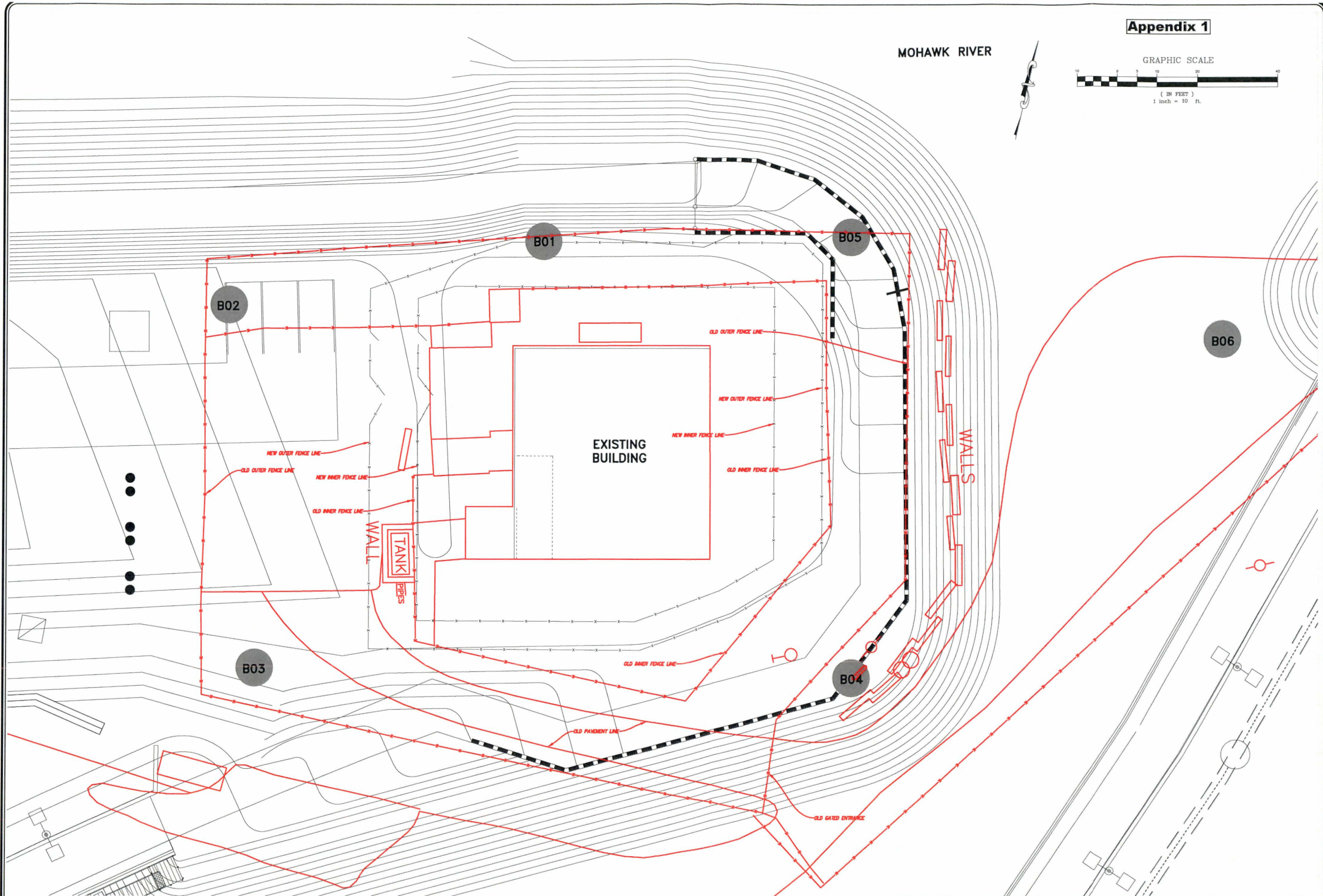
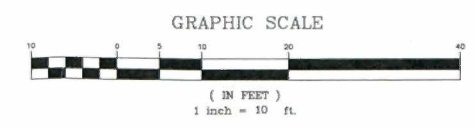
No changes were made to methodologies or calculations.

References:

- [1] NRC letter Rensselaer Polytechnic Institute - Supplemental Information Needed for Acceptance of the Application for a License Amendment Re Modification to the Restricted and Exclusion Areas for the Renewed Facility License No. CX-22 (EPID: L-2019-LLA-0254), ADAMS Accession No. ML19340C076
- [2] Safety Evaluation Report Related to the Renewal of Facility Operating License No. CX-22 for the Rensselaer Polytechnic Institute Critical Experiments Facility, Rensselaer Polytechnic Institute, June 2011, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, ADAMS Accession No. ML111110690

Appendix 1

MOHAWK RIVER



HERSHBERG & HERSHBERG
Consulting Engineers
and Land Surveyors
18 Locust Street
Albany, New York 12203

ALTERATION OF THIS DOCUMENT EXCEPT BY A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR, IS ILLEGAL.



DATE	
REMARKS	
REVISIONS	

RPI BORINGS
MOHAWK HARBOR
SCHENECTADY NEW YORK

FILE: 2012-0158-RPI SCALE: 1"=10' DATE: 1-8-2020 CHK: JMH GY: SMC 2012-0158-RPI

FOR MUNICIPAL APPROVAL ONLY-NOT INTENDED FOR CONSTRUCTION

RPI

Safety Analysis of construction activities surrounding RPI RCF

Peter F. Caracappa, Ph.D., CHP

Rev. 9/12/15

The following is an analysis of the general construction plan and activities in the area surrounding the RPI RCF, performed in accordance with the requirements of 10CFR50.59 paragraph (d)(1) which states "The licensee shall maintain records of changes in the facility, of changes in procedures, and of tests and experiments made pursuant to paragraph (c) of this section. These records must include a written evaluation which provides the bases for the determination that the change, test or experiment does not require a license amendment pursuant to paragraph (c)(2) of this section."

This analysis addresses only the general terms of the plan for the land surrounding the RPI reactor, as plans and designs will continue to evolve over time. Additional specific analyses will be completed for any changes that lead to demonstrable impact on the description of the facility or procedures of the facility.

Overview:

The RCF sits on land owned by RPI, but is surrounded by industrial land previously belonging to the American Locomotive Corporation (ALCO), eventually transferred to the control of the Schenectady Metroplex, and industrial development authority. The Metroplex has instituted plans to redevelop the land into a mixed-use development including residential property, commercial activities, a hotel, and a marina. An artist's rendering of the plan is shown in Figure 1.



Figure 1 - Artist's Rendering of redevelopment of land surrounding RCF, shown at center

This development, when completed, will change the geography and demography of the surrounding area as outlined in section 2.1 and 2.2 of the SAR.

The redevelopment process is expected to include several features:

- Construction activities in land previously dedicated to industrial use
- Excavation and construction of harbor facility
- Reconfiguration of RCF fence line perimeters
- Removal of exhaust stack

Basis for analysis

For the given activities, compliance with the conditions of 10CFR50.59(c) are demonstrated by comparison against:

1. The RCF Technical Specifications, for compliance with 10CFR50.59(c)(1)(i)
2. The radiation protection standards for members of the public contained in 10CFR20, for compliance with 10CFR50.59(c)(1)(ii)

Again, the analysis contained herein only addresses the general concepts associated with the project plan, with more detailed analyses to be completed for specific activities when complete design plans are established.

This analysis does not address security issues associated with any of the proposed changes. Changes to the Security Plan, if necessary, will be addressed by the process outlined in the Security Plan and/or as described in 10CFR50.54(p).

Analysis

The only area of the Technical Specification potentially impacted by the conceptual design is Section 5.1, which provides a physical description of the fence radius. The proposed changes do not result in an obvious conflict with the description in that section. This condition will be addressed in detail when a new fence line design is proposed.

The limiting factor for the safety of the facility is the dose to members of the public associated with direct exposure to radiation released from the operation of the reactor, and from environmental releases from the reactor operations. Specifically, dose rate is limited to no more than 2 mrem/hour in any accessible area, and to no more than 100 mrem accumulated dose to members of the public in a year.

In the relicensing process completed in 2011, confirmatory measurements were made and extrapolated to the conditions of maximum licensed operation. It was shown at that time that the maximum dose rate at the position of the inner fence was 1.3 mrem/hour, at the position of closest approach to the reactor itself. Although the public is generally restricted from accessing the position of land

between the two fence lines, at times individuals not designated radiation workers or under the supervision of cognizant individuals may frequent this region, so using the inner fence line is conservative.

Although the exact positioning of the inner fence line is not yet determined, it does not appear that it will be close enough at any point to result in exceeding the given thresholds even under maximum operating conditions. Since compliance is maintained at the fence line boundary, changes to geography and demography beyond it will not result in violation of dose limits, even under maximum operating conditions.

Likewise, the calculation of dose from environmental release (of Ar-41 generated during reactor operations) takes no credit for stack height, distance from release, occupancy, or population distribution. Effectively it assumes that the maximally exposed individual remains at the stack release point. Therefore any changes in geographic and demographic layout of surrounding community does not impact compliance with dose limits.

Safety Analysis of Fence Line Reconfiguration

Peter F. Caracappa, Ph.D., CHP

September 15, 2015

The following is an analysis of the reconfiguration of the fence line boundaries surrounding the RCF, performed in accordance with the requirements of 10CFR50.59 paragraph (d)(1) which states "The licensee shall maintain records of changes in the facility, of changes in procedures, and of tests and experiments made pursuant to paragraph (c) of this section. These records must include a written evaluation which provides the bases for the determination that the change, test or experiment does not require a license amendment pursuant to paragraph (c)(2) of this section."

The RCF fences perform both a safety and a security function. This analysis addresses only the relative position of the fence line, and **not** the exact layout nor the construction of the fence, which will be addressed, if necessary, through changes to the Security Plan performed in accordance with the process given in 10 CFR 50.54(p).

Overview

Construction activity in the land surrounding the RCF has necessitated adjustments to the fence lines surrounding the facility. A harbor is under construction to the south of the facility, with an opening to the river that will be established to the east of the facility. Land beyond the facility boundary will be re-graded, and a walking path along the harbor and river sides of the facility will be installed.

The fences surrounding the RCF are described in the specifications in TS 5.1, Site and Facility Description, which states:

The facility is located on a site situated on the south bank of the Mohawk River in the City of Schenectady. An inner fence of greater than 30 feet radius defines the restricted area. An outer fence and riverbank of greater than 50 feet radius defines the exclusion area.

The restricted area is accessible only to those that are approved and designated radiation workers, or those under the supervision of such workers. Access to the exclusion area is limited, but may at times be granted to individuals not meeting the definition of a radiation worker. Therefore the RCF safety analyses have generally used the dose at the position of the inner fence to show compliance with dose to members of the public.

The inner fence position is not modified uniformly from the previous layout. The fence line along the north (river) side of the facility is maintained from the previous position. Along the west side of the facility, the fence line has been moved slightly further from the reactor building. Along the south and east sides of the facility, the fence has been moved closer to the reactor building by 7-10 feet, depending upon

the location. Exact measurements, layouts, and diagrams are omitted from this document to avoid potential disclosure of security related information.

The inner fence relocation will be completed in a single phase to establish a new permanent boundary. To accommodate continuing construction, the outer fence is being established at an interim location greater than existing fence boundary, which will be later modified to a permanent position that is either equal or closer to the reactor building compared to the previous boundary.

Basis for analysis

For this project, compliance with the conditions of 10CFR50.59(c) are demonstrated by comparison against:

1. The RCF Technical Specifications, for compliance with 10CFR50.59(c)(1)(i)
2. The radiation protection standards for members of the public contained in 10CFR20, for compliance with 10CFR50.59(c)(1)(ii)

Analysis

1. The RCF Technical Specifications, for compliance with 10CFR50.59(c)(1)(i)

The specification of TS 5.1 states:

The facility is located on a site situated on the south bank of the Mohawk River in the City of Schenectady. An inner fence of greater than 30 feet radius defines the restricted area. An outer fence and riverbank of greater than 50 feet radius defines the exclusion area.

The fences are not circular, but instead are reasonably rectangular in layout. It is assumed that compliance with this TS section is demonstrated if a circle of the specified radius can be placed within the fence line where the fence falls outside the circle in every direction and does not intersect the fence at any position.

The updated inner fence position can accommodate a circle of radius 30 feet. The updated outer fence, being further from the reactor building than the previous configuration, clearly meets this standard. The intended design of the final position of the outer fence accommodates a circle of radius 50 feet, although this will be confirmed against the as-built conditions when that fence position is established.

2. The radiation protection standards for members of the public contained in 10CFR20, for compliance with 10CFR50.59(c)(1)(ii)

A characterization of the dose rate at the previous fence line was completed as part of the relicensing process. Dose was measured at a consistent reactor power level of 13 W, and extrapolated to the maximum licensed condition of 100 W.

The maximum dose observed from this operation was on the west side of the facility (due to the presence of a "window" filled with low density concrete rather than the high density concrete making up the remainder of the reactor room walls). However, the inner fence line in that direction is further from building than previous position, and therefore will not be increased due to the fence changes. The next highest dose position was along the south side of the building. Along the east side, the measured dose was lower, and the change in the fence position is slightly smaller, so the south side fence dose is considered the limiting condition.

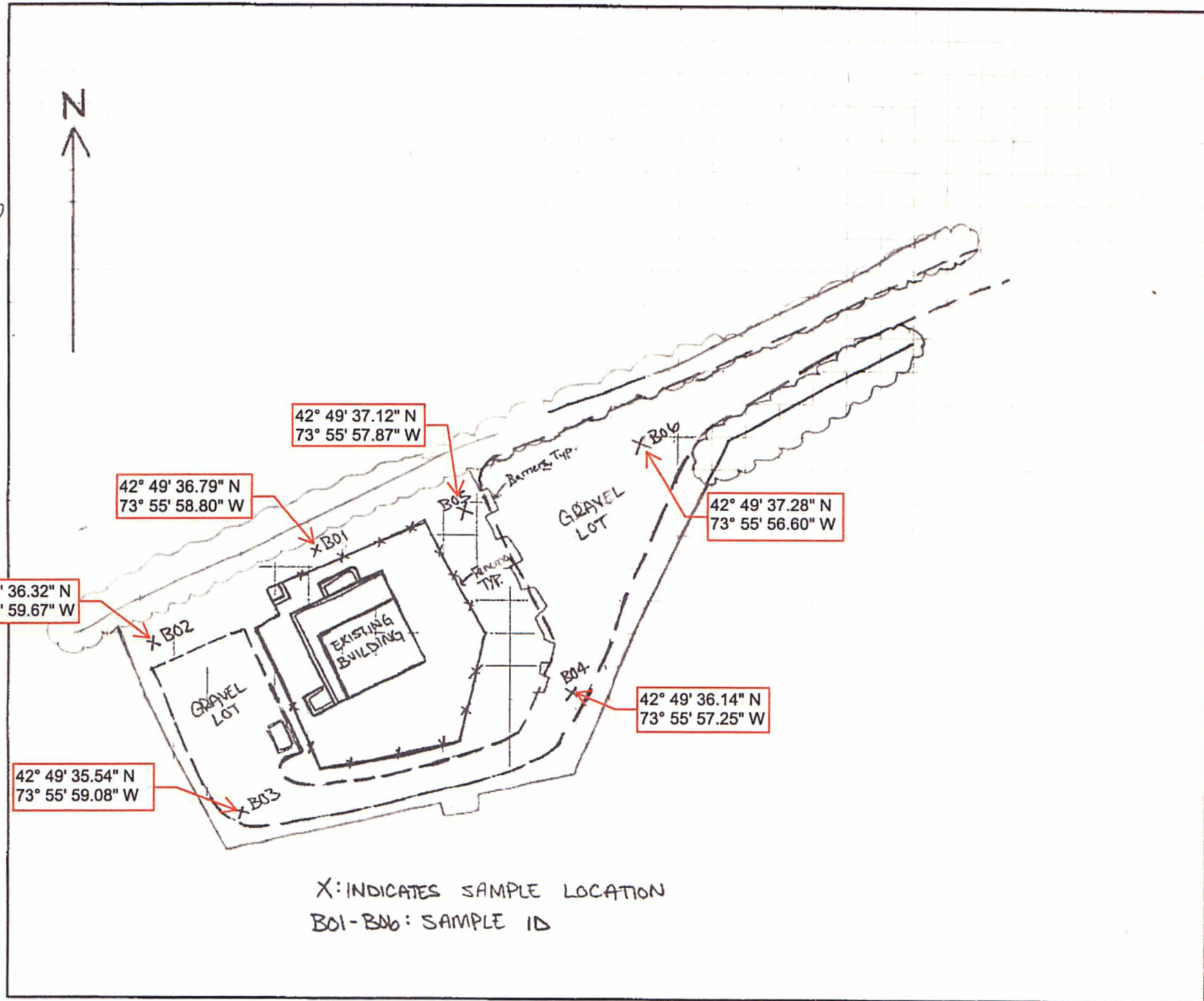
The predicted exposure rate for full power operation at that position was calculated as 1.15 mrem/hour, and the position at the fence line was approximately 45 feet from the centerline of the reactor. The new inner fence position is approximately 35 feet from the center line of the reactor. Assuming the dose rate follows a $1/r^2$ relationship, the predicted dose rate at the new fence line at maximum licensed power would be 1.9 mrem/hour, which remains below the 2 mrem/hour threshold.

The facility integrated power is limited to no more than 2 kw-hr per year, which would result in a maximum possible accumulated dose to members of the public of 38 mrem per year, below the limit of 100 mrem per year.

These values are conservative because (a) members of the public are not generally able to access the position of the inner fence line, (b) those that do are generally present for only a short time in a transient manner, and (c) maximum operational power is administratively limited to 15 W, and typical annual integrated power is much less than 2 kw-hr.

Conclusion

The changes to the fence line position do not require a change to the facility license under 10 CFR 50.59.



December 01, 2014

Kelly Miller
Pace Analytical New York
2190 Technology Drive
Schenectady, NY 12308

RE: Project: 14100828
Pace Project No.: 30133084

Dear Kelly Miller:

Enclosed are the analytical results for sample(s) received by the laboratory on October 28, 2014. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Carin Ferris
carin.ferris@pacelabs.com
Project Manager

Enclosures



REPORT OF LABORATORY ANALYSIS

This report shall not be reproduced, except in full,
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CERTIFICATIONS

Project: 14100828

Pace Project No.: 30133084

Pennsylvania Certification IDs

1638 Roseytown Rd Suites 2,3&4, Greensburg, PA 15601

ACLASS DOD-ELAP Accreditation #: ADE-1544

Alabama Certification #: 41590

Arizona Certification #: AZ0734

Arkansas Certification

California/TNI Certification #: 04222CA

Colorado Certification

Connecticut Certification #: PH-0694

Delaware Certification

Florida/TNI Certification #: E87683

Guam/PADEP Certification

Hawaii/PADEP Certification

Idaho Certification

Illinois/PADEP Certification

Indiana/PADEP Certification

Iowa Certification #: 391

Kansas/TNI Certification #: E-10358

Kentucky Certification #: 90133

Louisiana DHH/TNI Certification #: LA140008

Louisiana DEQ/TNI Certification #: 4086

Maine Certification #: PA00091

Maryland Certification #: 308

Massachusetts Certification #: M-PA1457

Michigan/PADEP Certification

Missouri Certification #: 235

Montana Certification #: Cert 0082

Nebraska Certification #: NE-05-29-14

Nevada Certification

New Hampshire/TNI Certification #: 2976

New Jersey/TNI Certification #: PA 051

New Mexico Certification

New York/TNI Certification #: 10888

North Carolina Certification #: 42706

North Dakota Certification #: R-190

Oregon/TNI Certification #: PA200002

Pennsylvania/TNI Certification #: 65-00282

Puerto Rico Certification #: PA01457

South Dakota Certification

Tennessee Certification #: TN2867

Texas/TNI Certification #: T104704188

Utah/TNI Certification #: PA014572014-4

Vermont Dept. of Health: ID# VT-0282

Virgin Island/PADEP Certification

Virginia/VELAP Certification #: 460198

Washington Certification #: C868

West Virginia DEP Certification #: 143

West Virginia DHHR Certification #: 9964C

Wisconsin/PADEP Certification

Wyoming Certification #: 8TMS-Q

REPORT OF LABORATORY ANALYSIS

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SAMPLE SUMMARY

Project: 14100828

Pace Project No.: 30133084

Lab ID	Sample ID	Matrix	Date Collected	Date Received
30133083001	BO1-A	Solid	10/23/14 08:15	10/28/14 10:15
30133084002	BO1-B	Solid	10/23/14 08:25	10/28/14 10:15
30133084003	BO2-A	Solid	10/23/14 08:55	10/28/14 10:15
30133084004	BO2-B	Solid	10/23/14 09:25	10/28/14 10:15
30133084005	BO3-A	Solid	10/23/14 10:00	10/28/14 10:15
30133084006	BO3-B	Solid	10/23/14 10:15	10/28/14 10:15
30133084007	BO4-A	Solid	10/23/14 11:00	10/28/14 10:15
30133084008	BO4-B	Solid	10/23/14 11:10	10/28/14 10:15
30133084009	BO5-A	Solid	10/23/14 10:35	10/28/14 10:15
30133084010	BO5-B	Solid	10/23/14 10:40	10/28/14 10:15
30133084011	BO6-A	Solid	10/23/14 11:40	10/28/14 10:15
30133084012	BO6-B	Solid	10/23/14 12:00	10/28/14 10:15

REPORT OF LABORATORY ANALYSIS

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SAMPLE ANALYTE COUNT

Project: 14100828
Pace Project No.: 30133084

Lab ID	Sample ID	Method	Analysts	Analytes Reported
30133083001	BO1-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084002	BO1-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2
		HSL-300	LAL	2
30133084003	BO2-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084004	BO2-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2
		HSL-300	LAL	2
30133084005	BO3-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084006	BO3-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084007	BO4-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084008	BO4-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084009	BO5-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
		HSL-300	LAL	2
30133084010	BO5-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2
30133084011	BO6-A	EPA 901.1	MAH	10
		EPA 9310	FCC	2
		HSL-300	LAL	2
30133084012	BO6-B	EPA 901.1	MAH	10
		EPA 9310	FCC	2

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

Sample: BO1-A Lab ID: 30133083001 Collected: 10/23/14 08:15 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.000 ± 1.768 (3.162) C:NA T:NA	pCi/g	11/25/14 13:50	14913-49-6	
Bismuth-214	EPA 901.1	1.011 ± 0.281 (0.188)	pCi/g	11/25/14 13:50	14733-03-0	
Lead-212	EPA 901.1	1.082 ± 0.278 (0.274) C:NA T:NA	pCi/g	11/25/14 13:50	15092-94-1	
Lead-214	EPA 901.1	1.212 ± 0.306 (0.203)	pCi/g	11/25/14 13:50	15067-28-4	
Potassium-40	EPA 901.1	6.800 ± 2.056 (2.069) C:NA T:NA	pCi/g	11/25/14 13:50	13966-00-2	
Radium-226	EPA 901.1	1.115 ± 0.280 (0.188) C:NA T:NA	pCi/g	11/25/14 13:50	13982-63-3	
Radium-228	EPA 901.1	1.200 ± 0.424 (0.466) C:NA T:NA	pCi/g	11/25/14 13:50	15262-20-1	
Thallium-208	EPA 901.1	0.426 ± 0.134 (0.106) C:NA T:NA	pCi/g	11/25/14 13:50	14913-50-9	
Thorium-234	EPA 901.1	1.221 ± 2.942 (5.060) C:NA T:NA	pCi/g	11/25/14 13:50	15065-10-8	
Uranium-235	EPA 901.1	0.254 ± 0.164 (0.172) C:NA T:NA	pCi/g	11/25/14 13:50	15117-96-1	
Gross Alpha	EPA 9310	9.63 ± 5.63 (9.05) C:NA T:NA	pCi/g	11/14/14 06:24	12587-46-1	
Gross Beta	EPA 9310	7.77 ± 3.30 (5.24) C:NA T:NA	pCi/g	11/14/14 06:24	12587-47-2	

Sample: BO1-B Lab ID: 30133084002 Collected: 10/23/14 08:25 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.623 ± 1.433 (2.575) C:NA T:NA	pCi/g	11/25/14 13:50	14913-49-6	
Bismuth-214	EPA 901.1	0.840 ± 0.267 (0.198)	pCi/g	11/25/14 13:50	14733-03-0	
Lead-212	EPA 901.1	1.013 ± 0.282 (0.218) C:NA T:NA	pCi/g	11/25/14 13:50	15092-94-1	
Lead-214	EPA 901.1	0.862 ± 0.281 (0.242)	pCi/g	11/25/14 13:50	15067-28-4	
Potassium-40	EPA 901.1	5.635 ± 2.217 (2.445) C:NA T:NA	pCi/g	11/25/14 13:50	13966-00-2	
Radium-226	EPA 901.1	0.844 ± 0.268 (0.198) C:NA T:NA	pCi/g	11/25/14 13:50	13982-63-3	
Radium-228	EPA 901.1	0.910 ± 0.361 (0.469) C:NA T:NA	pCi/g	11/25/14 13:50	15262-20-1	
Thallium-208	EPA 901.1	0.441 ± 0.141 (0.089) C:NA T:NA	pCi/g	11/25/14 13:50	14913-50-9	
Thorium-234	EPA 901.1	1.928 ± 1.189 (2.410) C:NA T:NA	pCi/g	11/25/14 13:50	15065-10-8	
Uranium-235	EPA 901.1	0.127 ± 0.112 (0.143) C:NA T:NA	pCi/g	11/25/14 13:50	15117-96-1	
Gross Alpha	EPA 9310	9.08 ± 5.78 (9.97) C:NA T:NA	pCi/g	11/14/14 06:24	12587-46-1	
Gross Beta	EPA 9310	9.11 ± 3.34 (4.82) C:NA T:NA	pCi/g	11/14/14 06:24	12587-47-2	
Thorium-232	HSL-300	1.39 ± 0.489 (0.284) C:NA T:85%	pCi/g	11/14/14 07:24	7440-29-1	N2

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

Sample: BO1-B **Lab ID: 30133084002** Collected: 10/23/14 08:25 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Uranium-238	HSL-300	0.701 ± 0.269 (0.110) C:NA T:107%	pCi/g	11/13/14 20:56		N2

Sample: BO2-A **Lab ID: 30133084003** Collected: 10/23/14 08:55 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.000 ± 0.615 (0.967) C:NA T:NA	pCi/g	11/25/14 14:18	14913-49-6	
Bismuth-214	EPA 901.1	0.675 ± 0.233 (0.183)	pCi/g	11/25/14 14:18	14733-03-0	
Lead-212	EPA 901.1	0.610 ± 0.191 (0.161) C:NA T:NA	pCi/g	11/25/14 14:18	15092-94-1	
Lead-214	EPA 901.1	0.624 ± 0.189 (0.138)	pCi/g	11/25/14 14:18	15067-28-4	
Potassium-40	EPA 901.1	7.661 ± 1.801 (1.384) C:NA T:NA	pCi/g	11/25/14 14:18	13966-00-2	
Radium-226	EPA 901.1	0.667 ± 0.156 (0.183) C:NA T:NA	pCi/g	11/25/14 14:18	13982-63-3	
Radium-228	EPA 901.1	0.335 ± 0.181 (0.359) C:NA T:NA	pCi/g	11/25/14 14:18	15262-20-1	
Thallium-208	EPA 901.1	0.129 ± 0.072 (0.101) C:NA T:NA	pCi/g	11/25/14 14:18	14913-50-9	
Thorium-234	EPA 901.1	0.587 ± 1.012 (3.462) C:NA T:NA	pCi/g	11/25/14 14:18	15065-10-8	
Uranium-235	EPA 901.1	0.107 ± 0.097 (0.116) C:NA T:NA	pCi/g	11/25/14 14:18	15117-96-1	
Gross Alpha	EPA 9310	26.3 ± 9.29 (11.6) C:NA T:NA	pCi/g	11/14/14 06:24	12587-46-1	
Gross Beta	EPA 9310	22.2 ± 5.50 (4.74) C:NA T:NA	pCi/g	11/14/14 06:24	12587-47-2	

Sample: BO2-B **Lab ID: 30133084004** Collected: 10/23/14 09:25 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.590 ± 1.555 (2.706) C:NA T:NA	pCi/g	11/30/14 21:12	14913-49-6	
Bismuth-214	EPA 901.1	1.324 ± 0.377 (0.360)	pCi/g	11/30/14 21:12	14733-03-0	
Lead-212	EPA 901.1	1.885 ± 0.481 (0.363) C:NA T:NA	pCi/g	11/30/14 21:12	15092-94-1	
Lead-214	EPA 901.1	1.948 ± 0.466 (0.275)	pCi/g	11/30/14 21:12	15067-28-4	
Potassium-40	EPA 901.1	10.901 ± 2.609 (1.716) C:NA T:NA	pCi/g	11/30/14 21:12	13966-00-2	
Radium-226	EPA 901.1	1.614 ± 0.379 (0.360) C:NA T:NA	pCi/g	11/30/14 21:12	13982-63-3	
Radium-228	EPA 901.1	1.816 ± 0.521 (0.436) C:NA T:NA	pCi/g	11/30/14 21:12	15262-20-1	
Thallium-208	EPA 901.1	0.858 ± 0.324 (0.214) C:NA T:NA	pCi/g	11/30/14 21:12	14913-50-9	

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

Sample: BO2-B Lab ID: 30133084004 Collected: 10/23/14 09:25 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Thorium-234	EPA 901.1	0.871 ± 1.499 (5.732) C:NA T:NA	pCi/g	11/30/14 21:12	15065-10-8	
Uranium-235	EPA 901.1	0.404 ± 0.158 (0.254) C:NA T:NA	pCi/g	11/30/14 21:12	15117-96-1	
Gross Alpha	EPA 9310	10.5 ± 6.62 (11.5) C:NA T:NA	pCi/g	11/18/14 07:13	12587-46-1	
Gross Beta	EPA 9310	11.4 ± 4.15 (5.98) C:NA T:NA	pCi/g	11/18/14 07:13	12587-47-2	
Thorium-232	HSL-300	1.20 ± 0.427 (0.232) C:NA T:67%	pCi/g	11/17/14 15:51	7440-29-1	N2
Uranium-238	HSL-300	1.32 ± 0.446 (0.151) C:NA T:92%	pCi/g	11/18/14 10:48		N2

Sample: BO3-A Lab ID: 30133084005 Collected: 10/23/14 10:00 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	1.186 ± 1.136 (1.316) C:NA T:NA	pCi/g	11/30/14 20:41	14913-49-6	
Bismuth-214	EPA 901.1	0.654 ± 0.195 (0.153)	pCi/g	11/30/14 20:41	14733-03-0	
Lead-212	EPA 901.1	0.717 ± 0.176 (0.171) C:NA T:NA	pCi/g	11/30/14 20:41	15092-94-1	
Lead-214	EPA 901.1	0.691 ± 0.213 (0.180)	pCi/g	11/30/14 20:41	15067-28-4	
Potassium-40	EPA 901.1	8.762 ± 2.095 (1.286) C:NA T:NA	pCi/g	11/30/14 20:41	13966-00-2	
Radium-226	EPA 901.1	0.645 ± 0.192 (0.153) C:NA T:NA	pCi/g	11/30/14 20:41	13982-63-3	
Radium-228	EPA 901.1	0.994 ± 0.287 (0.241) C:NA T:NA	pCi/g	11/30/14 20:41	15262-20-1	
Thallium-208	EPA 901.1	0.334 ± 0.094 (0.049) C:NA T:NA	pCi/g	11/30/14 20:41	14913-50-9	
Thorium-234	EPA 901.1	0.637 ± 0.802 (1.458) C:NA T:NA	pCi/g	11/30/14 20:41	15065-10-8	
Uranium-235	EPA 901.1	0.036 ± 0.060 (0.106) C:NA T:NA	pCi/g	11/30/14 20:41	15117-96-1	
Gross Alpha	EPA 9310	9.49 ± 5.68 (8.75) C:NA T:NA	pCi/g	11/14/14 07:53	12587-46-1	
Gross Beta	EPA 9310	6.53 ± 3.51 (6.05) C:NA T:NA	pCi/g	11/14/14 07:53	12587-47-2	

Sample: BO3-B Lab ID: 30133084006 Collected: 10/23/14 10:15 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	1.477 ± 1.689 (2.365) C:NA T:NA	pCi/g	11/30/14 18:09	14913-49-6	
Bismuth-214	EPA 901.1	1.397 ± 0.403 (0.262)	pCi/g	11/30/14 18:09	14733-03-0	
Lead-212	EPA 901.1	1.291 ± 0.315 (0.241) C:NA T:NA	pCi/g	11/30/14 18:09	15092-94-1	

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828
Pace Project No.: 30133084

Sample: BO3-B **Lab ID: 30133084006** Collected: 10/23/14 10:15 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Lead-214	EPA 901.1	1.124 ± 0.341 (0.279)	pCi/g	11/30/14 18:09	15067-28-4	
Potassium-40	EPA 901.1	7.842 ± 2.539 (2.217)	pCi/g	11/30/14 18:09	13966-00-2	
		C:NA T:NA				
Radium-226	EPA 901.1	1.324 ± 0.341 (0.262)	pCi/g	11/30/14 18:09	13982-63-3	
		C:NA T:NA				
Radium-228	EPA 901.1	1.386 ± 0.406 (0.341)	pCi/g	11/30/14 18:09	15262-20-1	
		C:NA T:NA				
Thallium-208	EPA 901.1	0.544 ± 0.160 (0.072)	pCi/g	11/30/14 18:09	14913-50-9	
		C:NA T:NA				
Thorium-234	EPA 901.1	2.395 ± 1.340 (2.120)	pCi/g	11/30/14 18:09	15065-10-8	
		C:NA T:NA				
Uranium-235	EPA 901.1	0.117 ± 0.123 (0.165)	pCi/g	11/30/14 18:09	15117-96-1	
		C:NA T:NA				
Gross Alpha	EPA 9310	5.67 ± 4.35 (7.57)	pCi/g	11/14/14 07:53	12587-46-1	
		C:NA T:NA				
Gross Beta	EPA 9310	5.96 ± 3.01 (5.09)	pCi/g	11/14/14 07:53	12587-47-2	
		C:NA T:NA				

Sample: BO4-A **Lab ID: 30133084007** Collected: 10/23/14 11:00 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.595 ± 1.230 (2.112)	pCi/g	11/30/14 18:25	14913-49-6	
		C:NA T:NA				
Bismuth-214	EPA 901.1	1.093 ± 0.306 (0.207)	pCi/g	11/30/14 18:25	14733-03-0	
Lead-212	EPA 901.1	1.150 ± 0.277 (0.254)	pCi/g	11/30/14 18:25	15092-94-1	
		C:NA T:NA				
Lead-214	EPA 901.1	1.370 ± 0.311 (0.153)	pCi/g	11/30/14 18:25	15067-28-4	
Potassium-40	EPA 901.1	8.958 ± 2.085 (1.026)	pCi/g	11/30/14 18:25	13966-00-2	
		C:NA T:NA				
Radium-226	EPA 901.1	1.247 ± 0.280 (0.207)	pCi/g	11/30/14 18:25	13982-63-3	
		C:NA T:NA				
Radium-228	EPA 901.1	0.895 ± 0.317 (0.554)	pCi/g	11/30/14 18:25	15262-20-1	
		C:NA T:NA				
Thallium-208	EPA 901.1	0.252 ± 0.113 (0.144)	pCi/g	11/30/14 18:25	14913-50-9	
		C:NA T:NA				
Thorium-234	EPA 901.1	2.312 ± 2.683 (4.398)	pCi/g	11/30/14 18:25	15065-10-8	
		C:NA T:NA				
Uranium-235	EPA 901.1	0.209 ± 0.106 (0.121)	pCi/g	11/30/14 18:25	15117-96-1	
		C:NA T:NA				
Gross Alpha	EPA 9310	10.4 ± 5.82 (8.81)	pCi/g	11/14/14 07:18	12587-46-1	
		C:NA T:NA				
Gross Beta	EPA 9310	4.88 ± 3.41 (6.32)	pCi/g	11/14/14 07:18	12587-47-2	
		C:NA T:NA				

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828
Pace Project No.: 30133084

Sample: BO4-B **Lab ID: 30133084008** Collected: 10/23/14 11:10 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	2.059 ± 2.475 (3.161) C:NA T:NA	pCi/g	11/30/14 18:26	14913-49-6	
Bismuth-214	EPA 901.1	1.340 ± 0.429 (0.317)	pCi/g	11/30/14 18:26	14733-03-0	
Lead-212	EPA 901.1	1.537 ± 0.404 (0.296) C:NA T:NA	pCi/g	11/30/14 18:26	15092-94-1	
Lead-214	EPA 901.1	1.637 ± 0.425 (0.238)	pCi/g	11/30/14 18:26	15067-28-4	
Potassium-40	EPA 901.1	8.378 ± 2.978 (2.743) C:NA T:NA	pCi/g	11/30/14 18:26	13966-00-2	
Radium-226	EPA 901.1	1.494 ± 0.385 (0.317) C:NA T:NA	pCi/g	11/30/14 18:26	13982-63-3	
Radium-228	EPA 901.1	0.765 ± 0.360 (0.964) C:NA T:NA	pCi/g	11/30/14 18:26	15262-20-1	
Thallium-208	EPA 901.1	0.408 ± 0.171 (0.158) C:NA T:NA	pCi/g	11/30/14 18:26	14913-50-9	
Thorium-234	EPA 901.1	1.736 ± 1.573 (2.998) C:NA T:NA	pCi/g	11/30/14 18:26	15065-10-8	
Uranium-235	EPA 901.1	0.176 ± 0.176 (0.217) C:NA T:NA	pCi/g	11/30/14 18:26	15117-96-1	
Gross Alpha	EPA 9310	13.3 ± 7.07 (11.4) C:NA T:NA	pCi/g	11/14/14 07:18	12587-46-1	
Gross Beta	EPA 9310	6.61 ± 3.20 (5.27) C:NA T:NA	pCi/g	11/14/14 07:18	12587-47-2	

Sample: BO5-A **Lab ID: 30133084009** Collected: 10/23/14 10:35 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.433 ± 0.664 (1.116) C:NA T:NA	pCi/g	11/30/14 15:31	14913-49-6	
Bismuth-214	EPA 901.1	0.405 ± 0.152 (0.141)	pCi/g	11/30/14 15:31	14733-03-0	
Lead-212	EPA 901.1	0.549 ± 0.163 (0.117) C:NA T:NA	pCi/g	11/30/14 15:31	15092-94-1	
Lead-214	EPA 901.1	0.647 ± 0.166 (0.073)	pCi/g	11/30/14 15:31	15067-28-4	
Potassium-40	EPA 901.1	5.874 ± 1.622 (1.526) C:NA T:NA	pCi/g	11/30/14 15:31	13966-00-2	
Radium-226	EPA 901.1	0.397 ± 0.149 (0.141) C:NA T:NA	pCi/g	11/30/14 15:31	13982-63-3	
Radium-228	EPA 901.1	0.399 ± 0.182 (0.442) C:NA T:NA	pCi/g	11/30/14 15:31	15262-20-1	
Thallium-208	EPA 901.1	0.226 ± 0.081 (0.065) C:NA T:NA	pCi/g	11/30/14 15:31	14913-50-9	
Thorium-234	EPA 901.1	0.083 ± 0.140 (3.615) C:NA T:NA	pCi/g	11/30/14 15:31	15065-10-8	
Uranium-235	EPA 901.1	0.040 ± 0.075 (0.112) C:NA T:NA	pCi/g	11/30/14 15:31	15117-96-1	
Gross Alpha	EPA 9310	2.70 ± 4.58 (9.98) C:NA T:NA	pCi/g	11/14/14 07:18	12587-46-1	
Gross Beta	EPA 9310	9.95 ± 3.95 (6.09) C:NA T:NA	pCi/g	11/14/14 07:18	12587-47-2	
Thorium-232	HSL-300	0.305 ± 0.207 (0.159) C:NA T:88%	pCi/g	11/25/14 07:45	7440-29-1	N2

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828
Pace Project No.: 30133084

Sample: BO5-A Lab ID: 30133084009 Collected: 10/23/14 10:35 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Uranium-238	HSL-300	0.234 ± 0.138 (0.130) C:NA T:108%	pCi/g	11/25/14 07:39		N2

Sample: BO5-B Lab ID: 30133084010 Collected: 10/23/14 10:40 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.495 ± 1.069 (1.850) C:NA T:NA	pCi/g	11/30/14 18:42	14913-49-6	
Bismuth-214	EPA 901.1	0.737 ± 0.246 (0.196)	pCi/g	11/30/14 18:42	14733-03-0	
Lead-212	EPA 901.1	0.804 ± 0.249 (0.206) C:NA T:NA	pCi/g	11/30/14 18:42	15092-94-1	
Lead-214	EPA 901.1	0.625 ± 0.230 (0.197)	pCi/g	11/30/14 18:42	15067-28-4	
Potassium-40	EPA 901.1	5.248 ± 1.728 (1.875) C:NA T:NA	pCi/g	11/30/14 18:42	13966-00-2	
Radium-226	EPA 901.1	0.738 ± 0.173 (0.196) C:NA T:NA	pCi/g	11/30/14 18:42	13982-63-3	
Radium-228	EPA 901.1	0.538 ± 0.285 (0.433) C:NA T:NA	pCi/g	11/30/14 18:42	15262-20-1	
Thallium-208	EPA 901.1	0.154 ± 0.088 (0.122) C:NA T:NA	pCi/g	11/30/14 18:42	14913-50-9	
Thorium-234	EPA 901.1	-1.169 ± 3.433 (3.923) C:NA T:NA	pCi/g	11/30/14 18:42	15065-10-8	
Uranium-235	EPA 901.1	0.188 ± 0.105 (0.113) C:NA T:NA	pCi/g	11/30/14 18:42	15117-96-1	
Gross Alpha	EPA 9310	13.0 ± 6.40 (9.25) C:NA T:NA	pCi/g	11/14/14 07:18	12587-46-1	
Gross Beta	EPA 9310	7.85 ± 3.20 (4.66) C:NA T:NA	pCi/g	11/14/14 07:18	12587-47-2	

Sample: BO6-A Lab ID: 30133084011 Collected: 10/23/14 11:40 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.527 ± 1.110 (1.990) C:NA T:NA	pCi/g	11/30/14 18:42	14913-49-6	
Bismuth-214	EPA 901.1	0.605 ± 0.260 (0.310)	pCi/g	11/30/14 18:42	14733-03-0	
Lead-212	EPA 901.1	0.781 ± 0.197 (0.172) C:NA T:NA	pCi/g	11/30/14 18:42	15092-94-1	
Lead-214	EPA 901.1	0.650 ± 0.234 (0.199)	pCi/g	11/30/14 18:42	15067-28-4	
Potassium-40	EPA 901.1	5.302 ± 1.899 (1.680) C:NA T:NA	pCi/g	11/30/14 18:42	13966-00-2	
Radium-226	EPA 901.1	0.686 ± 0.174 (0.310) C:NA T:NA	pCi/g	11/30/14 18:42	13982-63-3	
Radium-228	EPA 901.1	0.345 ± 0.179 (0.608) C:NA T:NA	pCi/g	11/30/14 18:42	15262-20-1	
Thallium-208	EPA 901.1	0.226 ± 0.108 (0.097) C:NA T:NA	pCi/g	11/30/14 18:42	14913-50-9	

REPORT OF LABORATORY ANALYSIS

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

Sample: BO6-A **Lab ID: 30133084011** Collected: 10/23/14 11:40 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Thorium-234	EPA 901.1	1.357 ± 0.891 (1.896) C:NA T:NA	pCi/g	11/30/14 18:42	15065-10-8	
Uranium-235	EPA 901.1	0.144 ± 0.079 (0.095) C:NA T:NA	pCi/g	11/30/14 18:42	15117-96-1	
Gross Alpha	EPA 9310	8.25 ± 5.40 (9.18) C:NA T:NA	pCi/g	11/14/14 06:58	12587-46-1	
Gross Beta	EPA 9310	4.24 ± 2.47 (4.30) C:NA T:NA	pCi/g	11/14/14 06:58	12587-47-2	
Thorium-232	HSL-300	0.433 ± 0.295 (0.381) C:NA T:86%	pCi/g	11/25/14 07:45	7440-29-1	N2
Uranium-238	HSL-300	0.348 ± 0.165 (0.126) C:NA T:113%	pCi/g	11/25/14 07:39		N2

Sample: BO6-B **Lab ID: 30133084012** Collected: 10/23/14 12:00 Received: 10/28/14 10:15 Matrix: Solid
PWS: Site ID: Sample Type:

Results reported on a "dry-weight" basis

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Bismuth-212	EPA 901.1	0.617 ± 0.773 (1.254) C:NA T:NA	pCi/g	11/30/14 18:58	14913-49-6	
Bismuth-214	EPA 901.1	0.813 ± 0.260 (0.202)	pCi/g	11/30/14 18:58	14733-03-0	
Lead-212	EPA 901.1	0.960 ± 0.286 (0.237) C:NA T:NA	pCi/g	11/30/14 18:58	15092-94-1	
Lead-214	EPA 901.1	1.251 ± 0.302 (0.182)	pCi/g	11/30/14 18:58	15067-28-4	
Potassium-40	EPA 901.1	12.526 ± 2.482 (0.868) C:NA T:NA	pCi/g	11/30/14 18:58	13966-00-2	
Radium-226	EPA 901.1	1.033 ± 0.223 (0.202) C:NA T:NA	pCi/g	11/30/14 18:58	13982-63-3	
Radium-228	EPA 901.1	1.113 ± 0.360 (0.302) C:NA T:NA	pCi/g	11/30/14 18:58	15262-20-1	
Thallium-208	EPA 901.1	0.390 ± 0.122 (0.088) C:NA T:NA	pCi/g	11/30/14 18:58	14913-50-9	
Thorium-234	EPA 901.1	2.273 ± 1.873 (3.404) C:NA T:NA	pCi/g	11/30/14 18:58	15065-10-8	
Uranium-235	EPA 901.1	0.126 ± 0.097 (0.135) C:NA T:NA	pCi/g	11/30/14 18:58	15117-96-1	
Gross Alpha	EPA 9310	9.58 ± 5.21 (7.53) C:NA T:NA	pCi/g	11/14/14 07:19	12587-46-1	
Gross Beta	EPA 9310	12.6 ± 3.96 (4.95) C:NA T:NA	pCi/g	11/14/14 07:19	12587-47-2	

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22169

Analysis Method: HSL-300

QC Batch Method: HSL-300

Analysis Description: HSL300(AS) Actinides

Associated Lab Samples: 30133084004

METHOD BLANK: 816466

Matrix: Solid

Associated Lab Samples: 30133084004

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Thorium-232	0.038 ± 0.074 (0.149) C:NA T:88%	pCi/g	11/17/14 15:48	N2
Uranium-238	-0.020 ± 0.074 (0.150) C:NA T:116%	pCi/g	11/18/14 10:46	N2

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22088

Analysis Method: HSL-300

QC Batch Method: HSL-300

Analysis Description: HSL300(AS) Actinides

Associated Lab Samples: 30133084002

METHOD BLANK: 813942

Matrix: Solid

Associated Lab Samples: 30133084002

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Thorium-232	-0.007 ± 0.127 (0.170) C:NA T:88%	pCi/g	11/14/14 07:20	N2
Uranium-238	0.091 ± 0.128 (0.252) C:NA T:111%	pCi/g	11/13/14 20:52	N2

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22187

Analysis Method: HSL-300

QC Batch Method: HSL-300

Analysis Description: HSL300(AS) Actinides

Associated Lab Samples: 30133084009, 30133084011

METHOD BLANK: 816488

Matrix: Solid

Associated Lab Samples: 30133084009, 30133084011

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Thorium-232	0.011 ± 0.137 (0.261) C:NA T:93%	pCi/g	11/25/14 07:45	N2
Uranium-238	0.189 ± 0.134 (0.152) C:NA T:114%	pCi/g	11/25/14 07:39	N2

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22324

Analysis Method: EPA 901.1

QC Batch Method: EPA 901.1

Analysis Description: 901.1 Gamma Spec Ingrowth

Associated Lab Samples: 30133084004, 30133084005

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22199

Analysis Method: EPA 901.1

QC Batch Method: EPA 901.1

Analysis Description: 901.1 Gamma Spec Ingrowth

Associated Lab Samples: 30133084009

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22104

Analysis Method: EPA 901.1

QC Batch Method: EPA 901.1

Analysis Description: 901.1 Gamma Spec Ingrowth

Associated Lab Samples: 30133083001, 30133084002, 30133084003

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch:	RADC/22183	Analysis Method:	EPA 9310
QC Batch Method:	EPA 9310	Analysis Description:	9310 Gross Alpha/Beta
Associated Lab Samples:	30133083001, 30133084002, 30133084003, 30133084005, 30133084006, 30133084007, 30133084008, 30133084009, 30133084010, 30133084011, 30133084012		

METHOD BLANK:	816480	Matrix:	Solid
Associated Lab Samples:	30133083001, 30133084002, 30133084003, 30133084005, 30133084006, 30133084007, 30133084008, 30133084009, 30133084010, 30133084011, 30133084012		

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Gross Alpha	0.009 ± 0.105 (0.254) C:NA T:NA	pCi/g	11/14/14 06:24	
Gross Beta	0.076 ± 0.111 (0.238) C:NA T:NA	pCi/g	11/14/14 06:24	

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22207

Analysis Method: EPA 9310

QC Batch Method: EPA 9310

Analysis Description: 9310 Gross Alpha/Beta

Associated Lab Samples: 30133084004

METHOD BLANK: 818188

Matrix: Solid

Associated Lab Samples: 30133084004

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Gross Alpha	0.005 ± 0.0883 (0.220) C:NA T:NA	pCi/g	11/18/14 07:13	
Gross Beta	0.098 ± 0.116 (0.244) C:NA T:NA	pCi/g	11/18/14 07:13	

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 14100828

Pace Project No.: 30133084

QC Batch: RADC/22279

Analysis Method: EPA 901.1

QC Batch Method: EPA 901.1

Analysis Description: 901.1 Gamma Spec Ingrowth

Associated Lab Samples: 30133084006, 30133084007, 30133084008, 30133084010, 30133084011, 30133084012

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

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QUALIFIERS

Project: 14100828
Pace Project No.: 30133084

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Act - Activity

Unc - Uncertainty: SDWA = 1.96 sigma count uncertainty, all other matrices = Expanded Uncertainty (95% confidence interval).

Gamma Spec = Expanded Uncertainty (95.4% Confidence Interval)

(MDC) - Minimum Detectable Concentration

Trac - Tracer Recovery (%)

Carr - Carrier Recovery (%)

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

ANALYTE QUALIFIERS

N2 The lab does not hold TNI accreditation for this parameter.

REPORT OF LABORATORY ANALYSIS

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Full data package

PACE-PA

1/2

CHAIN OF CUSTODY RECORD

PAGE 1 OF 2

Pace Analytical Services, Inc.

2190 Technology Drive, Schenectady, NY 12308
 Telephone (518) 346-4592 Fax (518) 381-6055
 www.pacelabs.com

LRF # 14100828

(LAB USE ONLY)

DISPOSAL REQUIREMENTS: (To be filled in by Client)



RETURN TO CLIENT



DISPOSAL BY RECEIVING LAB



ARCHIVAL BY RECEIVING LAB

Additional charges incurred for disposal (if hazardous) or archival.

Call for details.

CLIENT (REPORTS TO BE SENT TO): PACE				PROJECT#/PROJECT NAME: 14100828				ENTER ANALYSIS AND METHOD NUMBER REQUESTED											
PROJECT MANAGER: Kelly.Miller@PACELABS.COM				LOCATION (CITY/STATE) ADDRESS: NY				PRESERVATIVE CODE:								PRESERVATIVE KEY			
SAMPLED BY: (Please Print)				REQUIRED TURN AROUND TIME: 11/19/2014				BOTTLE TYPE:								0 - ICE			
SAMPLING FIRM:				NAME OF COURIER (IF USED):				BOTTLE SIZE:								1 - HCL			
ELECTRONIC RESULTS				NICOLE.JOHNSON@PACELABS.CO				LAB								2 - HNO3			
				SAMPLE ID												3 - H2SO4			
				DATE												4 - NaOH			
				TIME												5 - Zn. Acetate			
				MATRIX												6 - MeOH			
				GRAB/COMP												7 - NaHSO4			
				LAB SAMPLE ID (LAB USE ONLY)												8 - Other (Na2SO3)			
																30133084			
																REMARKS:			
B01-A				10/23/14 8:15 S				COMP AR41433				2 X				001			
B01-B				10/23/14 8:25 S				COMP AR41434				2 X X X				002			
B02-A				10/23/14 8:55 S				COMP AR41435				2 X				003			
B02-B				10/23/14 9:25 S				COMP AR41436				2 X X X				004			
B03-A				10/23/14 10:00 S				COMP AR41437				2 X				005			
B03-B				10/23/14 10:15 S				COMP AR41438				2 X				006			
B04-A				10/23/14 11:00 S				COMP AR41439				2 X				007			
B04-B				10/23/14 11:10 S				COMP AR41440				2 X				008			
B05-A				10/23/14 10:35 S				COMP AR41441				2 X X X				009			
B05-B				10/23/14 10:40 S				COMP AR41442				2 X				010			
AMBIENT OR CHILLED:				TEMP: 4.7				COC TAPE: (Y) N				PROPERLY PRESERVED: Y N				OTHER NOTES: Analytical Report: [LEVEL-2] EDD: EQUIS-DEC-DE			
RECEIVED BROKEN OR LEAKING: Y (N)				COC DISCREPANCIES: Y (N)				RECVD W/ HOLDING TIMES: Y N											
RELINQUISHED BY				RECEIVED BY				RELINQUISHED BY				RECEIVED BY				RELINQUISHED BY			
SIGNATURE: <i>[Signature]</i>				SIGNATURE: <i>[Signature]</i>				SIGNATURE: <i>[Signature]</i>				SIGNATURE: <i>[Signature]</i>				SIGNATURE: <i>[Signature]</i>			
PRINTED NAME: Patricia Nguyen				PRINTED NAME: Fed ex				PRINTED NAME: Scott Spill				PRINTED NAME: Scott Spill				PRINTED NAME: Scott Spill			
COMPANY: PACE				COMPANY: PACE				COMPANY: PACE				COMPANY: PACE				COMPANY: PACE			
DATE/TIME: 10/27/14 15:00				DATE/TIME: 10/27/14 15:00				DATE/TIME: 10/27/14 15:00				DATE/TIME: 10/27/14 15:00				DATE/TIME: 10/27/14 15:00			

CHAIN OF CUSTODY RECORD

PAGE 2 OF 2

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LRF # 14100828
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DISPOSAL REQUIREMENTS: (To be filled in by Client)

- ☐ RETURN TO CLIENT
☒ DISPOSAL BY RECEIVING LAB
☐ ARCHIVAL BY RECEIVING LAB

Additional charges incurred for disposal (if hazardous) or archival.
Call for details.

[illegible]

Revised COC

CHAIN OF CUSTODY RECORD

PAGE 1 OF 2

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DISPOSAL REQUIREMENTS: (To be filled in by Client)



RETURN TO CLIENT



DISPOSAL BY RECEIVING LAB



ARCHIVAL BY RECEIVING LAB

Additional charges incurred for disposal (if hazardous) or archival.

Call for details.

CLIENT (REPORTS TO BE SENT TO): PACE					PROJECT#/PROJECT NAME: 14100828					ENTER ANALYSIS AND METHOD NUMBER REQUESTED									
PROJECT MANAGER: Kelly.Miller@PACELABS.COM					LOCATION (CITY/STATE) ADDRESS: NY					PRESERVATIVE CODE:					PRESERVATIVE KEY				
SAMPLED BY: (Please Print)					REQUIRED TURN AROUND TIME: 11/19/2014					BOTTLE TYPE:					0 - ICE				
SAMPLING FIRM:					NAME OF COURIER (IF USED):					BOTTLE SIZE:					1 - HCL				
ELECTRONIC RESULTS					NICOLE.JOHNSON@PACELABS.COM					LAB					2 - HNO3				
SAMPLE ID					DATE					TIME					3 - H2SO4				
DATE					TIME					MATRIX					4 - NaOH				
GRAB/COMP					SAMPLE ID (LAB USE ONLY)					NUMBER OF CONTAINERS					5 - Zn, Acetate				
B01-A					10/23/14					8:15					S				
B01-B					10/23/14					8:25					S				
B02-A					10/23/14					8:55					S				
B02-B					10/23/14					9:25					S				
B03-A					10/23/14					10:00					S				
B03-B					10/23/14					10:15					S				
B04-A					10/23/14					11:00					S				
B04-B					10/23/14					11:10					S				
B05-A					10/23/14					10:35					S				
B05-B					10/23/14					10:40					S				
AMBIENT OR CHILLED:					TEMP:					COC TAPE: Y N					PROPERLY PRESERVED: Y N				
RECEIVED BROKEN OR LEAKING: Y N					COC DISCREPANCIES: Y N					RECVD W/ HOLDING TIMES: Y N					OTHER NOTES: Analytical Report [LEVEL-2] EDD: EQUIS-DEC-DE				
RELINQUISHED BY					RECEIVED BY					RELINQUISHED BY					RECEIVED BY				
SIGNATURE					SIGNATURE					SIGNATURE					SIGNATURE				
PRINTED NAME					PRINTED NAME					PRINTED NAME					PRINTED NAME				
COMPANY					COMPANY					COMPANY					COMPANY				
DATE/TIME					DATE/TIME					DATE/TIME					DATE/TIME				

S:\LOG\MDL\COCs

PAGE 2 OF 2

DISPOSAL REQUIREMENTS: (To be filled in by Client)

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LRF # 14100828
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☐ RETURN TO CLIENT
☒ DISPOSAL BY RECEIVING LAB
☐ ARCHIVAL BY RECEIVING LAB

**Additional charges incurred for disposal (if hazardous) or archival.
Call for details.**

[illegible]

SALVAGINOL COCS

Page 15 of 27



Sample Condition Upon Receipt

Client Name: Pace NY

Project # 30133084

Courier: ☒ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other _____

Tracking #: 60734419500

Custody Seal on Cooler/Box Present: ☒ yes ☐ no Seals intact: ☒ yes ☐ no Biological Tissue Is Frozen: Yes No

Packing Material: Bubble Wrap ☒ Bubble Bags ☒ None ☐ Other _____

Thermometer Used #6 Type of Ice: ☒ Wet ☐ Blue ☐ None ☒ Samples on ice, cooling process has begun

Cooler Temp.: Observed Temp.: 4.7 °C Correction Factor: 0.0 °C Final Temp: 4.7 °C

Date and Initials of person

examining contents SRA 10/28/14

Temp should be above freezing to 6°C

Comments:

Chain of Custody Present:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	1.
Chain of Custody Filled Out:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	2.
Chain of Custody Relinquished:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	3.
Sampler Name & Signature on COC:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	4.
Samples Arrived within Hold Time:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	5.
Short Hold Time Analysis (<72hr):	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A	6.
Rush Turn Around Time Requested:	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A	7.
Sufficient Volume:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	8.
Correct Containers Used:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	9.
-Pace Containers Used:	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A	
Containers Intact:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	10.
Filtered volume received for Dissolved tests	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	11.
Sample Labels match COC:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	12.
-Includes date/time/ID/Analysis Matrix:	<u>SI</u>	
All containers needing preservation have been checked.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	Initial when completed <u>SRA</u> Lot # of added preservative
Samples checked for dechlorination:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	14.
Headspace in VOA Vials (>6mm):	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	15.
Trip Blank Present:	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A	16.
Trip Blank Custody Seals Present	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution:

Field Data Required?

Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

Project Manager Review:

Carina Ferro

Date: _____

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e. out of hold, incorrect preservative, out of temp, incorrect containers)

Project Number: _____
Client Name: _____

30133084

[illegible]

Celebrating over 50 years of service

December 11, 2014

Mr. Stephen Luciano
Maxon ALCO Holdings, LLC
695 Rotterdam Industrial Park
Schenectady, NY 12306

VIA ELECTRONIC MAIL

Re: ALCO – RPI Parcel
Schenectady, NY

Dear Mr. Luciano:

On behalf of Maxon ALCO Holdings, LLC, Barton & Loguidice, Inc. has prepared the following report for the results of the sampling at the RPI Parcel bordering the ALCO site.

SUMMARY OF IRM ACTIVITIES

Soil boring activities were undertaken at the RPI Parcel Area in accordance with the approved Work Plan starting on October 23, 2014. A total of 6 Geoprobe borings were advanced on the property; locations are shown on Figure 1. Because of the presence of the teaching reactor on the RPI parcel, air monitoring for ionizing radiation (alpha, beta, gamma) was conducted and soil samples were screened for ionizing radiation.

SUMMARY OF SAMPLE RESULTS

Two soil samples were collected from each boring using a MacroCore sampler: one sample was collected at the interval of 0-8 feet (A) and one sample was collected at the interval of 8-16 feet (B). Soil samples were collected at locations shown on the attached sketch. A total of 12 soil samples were collected and analyzed for Volatile Organic Compounds (VOCs), Semi-VOCs (SVOCs), Pesticides/Polychlorinated Biphenyls (Pest/PCBs), Target Analyte List (TAL) Metals and Radiologicals (Gross Alpha, Beta and Gamma). Four (4) selected soil samples were also analyzed for Uranium 238 (U-238), Thorium 232 (Th-232) and a gamma spectrum. Ionizing radiation readings from screened soil samples did not exceed 25 micro-roentgens per hour (typical of background radiation). Detections are summarized on the attached tables. SVOCs, like those detected on the adjacent former Alco parcels, were detected in each of the soil samples. B01-A, B01-B, B02-A, B03-A, B04-A, B04-B, B05-A, and B06-A had one or more of the following at concentrations above their respective Restricted Residential Soil Cleanup Objective (SCO):

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Chrysene
- Indeno(1,2,3-cd)pyrene

The experience to

**listen.
solve.**



Mr. Stephen Luciano
Maxon ALCO Holdings, LLC
December 11, 2014
Page 2

The SVOCs that were detected were all polynuclear aromatic hydrocarbons (PAHs), which are components of coal; the PAH detections are consistent with the site-wide PAH detections at the ALCO site that constitute Area of Concern 3 that will be addressed by the soil cover. Metals were also detected in each of the soil samples. With the exception of arsenic, metals were detected at concentrations below their respective Restricted Residential Soil Cleanup Objective (SCO). Arsenic was detected at concentrations above its SCO in samples B01-B, B02-B, B03-A, B04-A, B04-B, B05-A, B05-B, B06-A, and B06-B. With respect to VOCs, there were ten petroleum-related trace detections; the detections were reported as roughly three orders of magnitude below their respective SCOs. Pesticides were detected at trace concentrations in eleven (11) of the twelve (12) samples but at concentrations below their respective SCOs. PCBs were not detected. Radionuclides were detected in each of the twelve (12) soil samples. With the exception of Radium-228, the radionuclides were detected at concentrations below their respective USEPA Soil Screening Limits (SSL) and/or at concentrations that are typical of coal ash. Radium-228 was detected at concentrations slightly above its respective USEPA SSL, but below the respective USEPA Soil Cleanup Criteria (SSC). The laboratory results for the soil samples are also attached to this letter.

Please feel free to contact the undersigned at (518) 218-1801 with any questions or need for additional information. None of the constituents detected during the boring program were unexpected and are consistent with historic SVOC, metal and VOCs detected on the adjacent BCP parcels.

Very truly yours,
BARTON & LOGUIDICE, Inc.

Andrew J. Barber
Sr. Environmental Consultant

AJB/ojf
Enc.

cc:	Steve Porter, Esq.	- Maxon ALCO Holdings LLC
	Paul Fallati	- Maxon ALCO Holdings LLC
	Dean Sommer, Esq.	- Young Sommer



Former ALCO Site Brownfield Cleanup Project

RPI Sampling

Table 1 - VOCs Sample Summary of Detection

COMPOUND	UNIT	Part 375 Restricted Use SCO's - Restricted Residential ⁽¹⁾	B01-A	B01-B	B02-A	B02-B	B03-A	B03-B	B04-A	B04-B	B05-A	B05-B	B06-A	B06-B	
			10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014
			VOCs												
1,2,4-Trimethylbenzene	ug/kg	52000	-	-	-	-	-	-	1 J	-	-	-	-	-	
2-Butanone	ug/kg	NA	-	3 J	-	-	-	-	2 J	-	-	-	-	2 J	
Acetone	ug/kg	100000	-	32	-	4 J	5 J	10	71	85	40	14	44	89	
Chloroform	ug/kg	4900	1 BJ	1 BJ	-	1 J	2 BJ	1 BJ	1 BJ	1 BJ	1 BJ	1 BJ	1 BJ	1 BJ	
m&p-Xylene	ug/kg	NA	1 J	-	-	-	-	-	3 J	-	-	-	1 J	-	
Methylene Chloride	ug/kg	100000	7 BJ	3 BJ	3 BJ	6 BJ	12 B	8 BJ	10 B	5 BJ	6 BJ	2 BJ	11 B	8 BJ	
o-Xylene	ug/kg	NA	-	-	-	-	-	-	2 J	-	-	-	-	-	
Toluene	ug/kg	100000	2 J	-	-	2 J	1 J	-	4 J	-	-	-	2 J	-	
Total Xylenes	ug/kg	100000	1 J	-	-	-	-	-	5 J	-	-	-	2 J	-	
Trichloroethene	ug/kg	21000	2 J	-	-	-	-	-	-	-	-	-	-	-	

Notes:

NA-Not Applicable

- (Not Analyzed For or not detected)

B - Denotes analyte observed in associated method blank or extraction blank. Analyte concentration should be considered as estimated.

J - Denotes an estimated concentration. The concentration result is greater than or equal to the Method Detection Limit (MDL) but less than the Practical Quantitation Limit (PQL).

1. NYSDEC Part 375 Table 375-6.8(b) Restricted Use Soil Cleanup Objectives (SCOs) for the Protection of Public Health.

Items in bold exceed SCO

Former ALCO Site Brownfield Cleanup Project
RPI Sampling
Table 2 - SVOCs Sample Summary of Detection

COMPOUND	UNIT	Part 375 Restricted Use SCO's - Restricted Residential ⁽¹⁾	B01-A	B01-B	B02-A	B02-A DUP	B02-B	B03-A	B03-B	B04-A	B04-B	B05-A	BO5-B	B06-A	B06-B	B06-B DUP
			10/23 /2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014
SVOCs																
% Total Solid	%	NA	87.9	88.6	83.2	86.4	82.1	90	88	88.7	89	88.4	77.8	88.4	81.6	82.4
2-Methylnaphthalene	ug/kg	NA	209	-	-	-	-	887	189	397	442	354	-	529	-	-
Benzo(a)anthracene	ug/kg	1000	2340	2220	978	-	-	772	914	1190	1100	2410	-	5620	453	-
Benzo(a)pyrene	ug/kg	1000	2910	1280	783	-	-	692	739	1170	1010	1520	-	6080	447	-
Benzo(b)fluoranthene	ug/kg	1000	3240	3480	1390	-	-	1110	969	3130	2980	3890	-	11700	459	-
Benzo(g,h,i)perylene	ug/kg	100000	3090	1160	743	-	-	546	523	1810	1470	1690	-	7410	-	-
Benzo(k)fluoranthene	ug/kg	3900	2880	1650	654	-	-	612	702	2220	1620	1390	-	5770	453	-
Chrysene	ug/kg	3900	3840	4040	1770	-	235	1340	1140	2470	2240	5170	495	7990	634	-
Dibenzofuran	ug/kg	5900	-	-	-	-	-	207	-	-	-	-	-	-	-	-
Fluoranthene	ug/kg	100000	2060	945	624	-	-	843	1150	1280	1190	1040	-	4190	619	-
Indeno(1,2,3-cd)pyrene	ug/kg	500	2670	1000	583	-	-	475	477	1690	1420	1380	-	6240	-	-
Naphthalene	ug/kg	100000	192	-	-	-	-	571	ND	213	246	291	-	458	-	-
Phenanthrene	ug/kg	100000	923	426	246	-	-	921	643	866	763	861	-	1350	-	-
Pyrene	ug/kg	100000	1960	1290	688	-	-	823	1180	1090	987	1030	-	5440	864	-

Note:
NA-Not Applicable
- (Not Analyzed For or not detected)
1. NYSDEC Part 375 Table 375-6.8(b) Restricted Use Soil Cleanup Objectives (SCOs) for the Protection of Public Health.
Items in bold exceed SCO.

Former ALCO Site Brownfield Cleanup Project

RPI Sampling

Table 3 - Metals Sample Summary of Detection

COMPOUND	UNIT	Part 375 Restricted Use SCO's - Restricted Residential ⁽¹⁾	B01-A	B01-B	B02-A	B02-B	B03-A	B03-B	B04-A	B04-B	B05-A	BO5-B	B06-A	B06- B
			10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014
Metals														
Mercury	mg/kg	0.81	0.293	0.0499	0.15	0.0618	0.229	0.463	0.178	0.0843	0.466	0.165	0.162	0.23
Aluminum	mg/kg	NA	2890	4470	13000	2380	5150	3830	2760	1300	4940	1990	1930	3610
Antimony	mg/kg	NA	1.65	2.89	2.45	1.33	1.18	0.899	2.81	1.43	2.29	3.84	9.68	2.42
Arsenic	mg/kg	16	10.3	20.2	15.9	29.1	20.7	14.6	92.5	165	31.8	50.5	93.9	21.7
Barium	mg/kg	400	69.1	32.5	65.7	47.4	34.6	30.5	45.2	48.1	259	77.8	33.1	42.4
Beryllium	mg/kg	72	-	-	-	-	0.481	-	-	-	-	-	-	-
Cadmium	mg/kg	4.3	-	2.16	1.09	0.534	-	0.485	1.2	-	1.1	1.52	0.9	0.765
Calcium	mg/kg	NA	1480	927	6570	1830	4170	1110	2210	19900	469	551	604	444
Chromium	mg/kg	110	11.9	46.3	28.2	12.4	13.9	14.8	18	6.73	15.9	13	25.4	26.4
Cobalt	mg/kg	NA	3.9	7.67	10.1	5.67	3.7	4.61	6.26	1.51	4.54	8.22	3.26	7.39
Copper	mg/kg	270	47.6	188	206	224	46.9	49.4	43.7	17	204	153	638	245
Iron	mg/kg	NA	25100	90600	55400	26900	24700	31200	66100	53800	53400	64800	41000	42600
Lead	mg/kg	400	63.9	51	225	49.8	55.7	54.3	88.7	51.1	264	154	209	83.2
Magnesium	mg/kg	NA	213	417	2750	297	1190	532	353	405	599	ND	105	691
Manganese	mg/kg	2000	79.1	334	964	178	154	156	459	76.2	155	93.3	40.7	110
Nickel	mg/kg	310	12.6	16.1	29.6	12.3	11	9.24	11.5	3.2	10.6	19.6	8.02	18.4
Potassium	mg/kg	NA	440	410	1420	464	700	578	1160	1580	936	430	675	613
Selenium	mg/kg	180	1.28	-	-	-	1.6	-	3.21	6.44	-	-	4.34	-
Sodium	mg/kg	NA	103	-	183	110	307	123	1030	1230	174	-	432	100
Vanadium	mg/kg	NA	14.1	38.2	42.2	19.6	19.5	14.1	31.2	18.7	22.7	22.5	20.7	19.9
Zinc	mg/kg	10000	17.1	45.2	115	22.4	34.4	28.9	13.5	8.42	49.5	40.7	44.6	27

Notes:

NA-Not Applicable

- (Not Analyzed For or not detected)

1. NYSDEC Part 375 Table 375-6.8(b) Restricted Use Soil Cleanup Objectives (SCOs) for the Protection of Public Health.

Items in bold exceed SCO

Former ALCO Site Brownfield Cleanup Project

RPI Sampling

Table 4 - Pesticides Sample Summary of Detection

COMPOUND	UNIT	Part 375 Restricted Use SCO's - Restricted Residential ⁽¹⁾	B01- A	B01- BS	B02- B	B03- A	B03- B	B04- A	B04- B	B05- A	B05- B	B06- A	B06- BS
			10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014	10/23 /2014
Pesticides													
4,4' -DDD	ug/kg	13000	-	-	-	-	-	2.1 PJ	3 PJ	-	-	-	-
4,4' -DDT	ug/kg	7900	-	-	-	-	-	3.1 PJ	4.2 P	-	6.2	2.6 PJ	-
alpha-BHC	ug/kg	480	-	-	-	-	-	-	-	-	1.5 PJ	-	-
beta-BHC	ug/kg	360	1.7 PJ	-	-	-	1.1 J	1.9 P	1.1 PJ	-	1.8 PJ	1.6 PJ	-
delta-BHC	ug/kg	100000	-	-	-	-	-	-	-	-	2.2	-	-
Endosulfan I	ug/kg	24000	-	-	-	-	-	-	5.3	-	-	-	-
Endosulfan II	ug/kg	24000	-	-	-	2.2 PJ	-	-	-	-	-	-	-
Endrin aldehyde	ug/kg	NA	2.6 PJ	-	1.9 PJ	-	-	8.4 P	11 P	4.2 P	2.4 PJ	-	-
Endrin ketone	ug/kg	NA	12 PJ	7.3 P	1.9 PJ	-	-	4.2 P	6.3 P	23 P	4 PJ	19 P	3.2 PJ
gamma-BHC (LINDANE)	ug/kg	1300	-	-	-	1.9 PJ	1.7 PJ	2.1 PJ	2.3 P	1.3 PJ	1.5 PJ	1.9 PJ	-
gamm-Chlordane	ug/kg	NA	-	-	-	-	-	1.4 PJ	1 PJ	-	1.3 J	-	-
Heptachlor epoxide	ug/kg	NA	-	-	-	-	1.6 PJ	-	2 P	2.3 P	-	1.9 J	-

Notes:

NA-Not Applicable

- (Not Analyzed For or not detected)

1. NYSDEC Part 375 Table 375-6.8(b) Restricted Use Soil Cleanup Objectives (SCOs) for the Protection of Public Health.

Items in bold exceed SCO

P - Indicates relative percent difference (RPD) between primary and secondary gas chromatograph (GC) column analysis exceeds 40 % or indicates percent difference (PD) between primary and secondary gas chromatograph (GC) column analysis exceeds 25 %.

J - Denotes an estimated concentration. The concentration result is greater than or equal to the Method Detection Limit (MDL) but less than the Practical Quantitation Limit (PQL).

Former ALCO Site Brownfield Cleanup Project

RPI Sampling

Table 5.1 - Radiological Sample Summary

Parameter	Unit	EPA Soil Screening Guidance Table A.1- Generic SSLs for Radionuclides ⁽¹⁾	B01-A	B01-B	B02-A	B02-B	B03-A	B03-B	B04-A	B04-B	B05-A	B05-B	B06-A	B06-B	
			10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014	10/23/ 2014
			Direct Ingestion of soil												
Radionuclides															
Bismuth-212	pCi/g	NA	0.000±1.7 68	0.623 ± 1.433	0.000 ± 0.615	0.590 ± 1.555	1.186 ± 1.136	1.477 ± 1.689	0.595 ± 1.230	2.059 ± 2.475	0.433 ± 0.664	0.495 ± 1.069	0.527 ± 1.110	0.617 ± 0.773	
Bismuth-214	pCi/g	NA	1.011±0.2 81	0.840 ± 0.267	0.675 ± 0.233	1.324 ± 0.377	0.654 ± 0.195	1.397 ± 0.403	1.093 ± 0.306	1.340 ± 0.429	0.405 ± 0.152	0.737 ± 0.246	0.605 ± 0.260	0.813 ± 0.260	
Lead-212	pCi/g	NA	1.082±0.2 78	1.013 ± 0.282	0.610 ± 0.191	1.885 ± 0.481	0.717 ± 0.176	1.291 ± 0.315	1.150 ± 0.277	1.537 ± 0.404	0.549 ± 0.163	0.804 ± 0.249	0.781 ± 0.197	0.960 ± 0.286	
Lead-214	pCi/g	NA	1.212±0.3 06	0.862 ± 0.281	0.624 ± 0.189	1.948 ± 0.466	0.691 ± 0.213	1.124 ± 0.341	1.370 ± 0.311	1.637 ± 0.425	0.647 ± 0.166	0.625 ± 0.230	0.650 ± 0.234	1.251 ± 0.302	
Postassium-40	pCi/g	12.8	6.800±2.0 56	5.635 ± 2.217	7.661 ± 1.801	10.901 ± 2.609	8.762 ± 2.095	7.842 ± 2.539	8.958 ± 2.085	8.378 ± 2.978	5.874 ± 1.622	5.248 ± 1.728	5.302 ± 1.899	12.526 ± 2.482	
Radium-226+D	pCi/g	1.09	1.115±0.2 80	0.844 ± 0.268	0.667 ± 0.156	1.614 ± 0.379	0.645 ± 0.192	1.324 ± 0.341	1.247 ± 0.280	1.494 ± 0.385	0.397 ± 0.149	0.738 ± 0.173	0.686 ± 0.174	1.033 ± 0.223	
Radium-228+D	pCi/g	0.35	1.200±0.4 24	0.910 ± 0.361	0.335 ± 0.181	1.816 ± 0.521	0.994 ± 0.287	1.386 ± 0.406	0.895 ± 0.317	0.765 ± 0.360	0.399 ± 0.182	0.538 ± 0.285	0.345 ± 0.179	1.113 ± 0.360	
Thallium-208	pCi/g	NA	0.426±0.1 34	0.441 ± 0.141	0.129 ± 0.072	0.858 ± 0.324	0.334 ± 0.094	0.544 ± 0.160	0.252 ± 0.113	0.408 ± 0.171	0.226 ± 0.081	0.154 ± 0.088	0.226 ± 0.108	0.390 ± 0.122	
Thorium-234	pCi/g	NA	1.221±2.9 42	1.928 ± 1.189	0.587 ± 1.012	0.871 ± 1.499	0.637 ± 0.802	2.395 ± 1.340	2.312 ± 2.683	1.736 ± 1.573	0.083 ± 0.140	1.169 ± 3.433	1.357 ± 0.891	2.273 ± 1.873	
Uranium-235+D	pCi/g	48.7	0.254±0.1 64	0.127 ± 0.112	0.107 ± 0.097	0.404 ± 0.158	0.036 ± 0.060	0.117 ± 0.123	0.209 ± 0.106	0.176 ± 0.176	0.040 ± 0.075	0.188 ± 0.105	0.144 ± 0.079	0.126 ± 0.097	
Gross Alpha	pCi/g	NA	9.63±5.63	5.78 ± 9.11 ±	9.29 ± 22.2 ±	6.62 ± 11.4 ±	5.68 ± 6.53 ±	4.35 ± 5.96 ±	5.82 ± 4.88 ±	7.07 ± 6.61 ±	4.58 ± 9.95 ±	6.40 ± 7.85 ±	5.40 ± 4.24 ±	5.21 ± 12.6 ±	
Gross Beta	pCi/g	NA	7.77±3.30	3.34 ± 1.39 ±	5.50 ± 0.489	4.15 ± 1.20 ±	3.51 ± 1.32 ±	3.01 ± 1.32 ±	3.41 ± 1.32 ±	3.20 ± 1.32 ±	3.95 ± 0.305 ±	3.20 ± 0.207	2.47 ± 0.433 ±	3.96 ± -	
Thorium-232	pCi/g	3.44	-	-	-	0.427	-	-	-	-	0.207	-	0.295	-	
Uranium-238+D	pCi/g	3.78	-	0.701 ± 0.269	-	1.32 ± 0.446	-	-	-	-	0.234 ± 0.138	-	0.348 ± 0.165	-	

*Note: The "+D" weight based concentrations only account for the concentration of the first isotope in a series and does not represent the total radioactivity.

1. USEPA Soil Screening Guidance for Radionuclides: Technical Background Document

Former ALCO Site Brownfield Cleanup Project

RPI Sampling

Table 5.2 - Radiological Sample Summary

Parameter	Unit s	Identification and Quantification of Radionuclides in Coal Ash- Appendix A ⁽¹⁾				B01-A 10/23/ 2014	B01-B 10/23/ 2014	B02-A 10/23/ 2014	B02-B 10/23/ 2014	B03-A 10/23/ 2014	B03-B 10/23/ 2014	B04-A 10/23/ 2014	B04-B 10/23/ 2014	B05-A 10/23/ 2014	B05-B 10/23/ 2014	B06-A 10/23/ 2014	B06-B 10/23/ 2014
		Commingle d Ash	Fly Ash	Bottom Ash	Coal												
Radionuclides																	
Bismuth- 112	pCi/ g	2.484 - 5.427	4.05 - 6.345	3.294 - 5.35	0 - 0.972	0.000 ± 1.768	0.623 ± 1.433	0.000 ± 0.615	0.590 ± 1.555	1.186 ± 1.136	1.477 ± 1.689	0.595 ± 1.230	2.059 ± 2.475	0.433 ± 0.664	0.495 ± 1.069	0.527 ± 1.110	0.617 ± 0.773
Bismuth- 114	pCi/ g	3.078 - 9.585	2.565 - 9.207	2.943 - 7.938	0.459 - 1.377	1.011 ± 0.281	0.840 ± 0.267	0.675 ± 0.233	1.324 ± 0.377	0.654 ± 0.195	1.397 ± 0.403	1.093 ± 0.306	1.340 ± 0.429	0.405 ± 0.152	0.737 ± 0.246	0.605 ± 0.260	0.813 ± 0.260
Lead-212	pCi/ g	2.133 - 5.13	3.807 - 6.237	2.943 - 5.643	0.378 - 0.648	1.082 ± 0.278	1.013 ± 0.282	0.610 ± 0.191	1.885 ± 0.481	0.717 ± 0.176	1.291 ± 0.315	1.150 ± 0.277	1.537 ± 0.404	0.549 ± 0.163	0.804 ± 0.249	0.781 ± 0.197	0.960 ± 0.286
Lead-214	pCi/ g	3.078 - 10.395	2.7 - 9.909	3.132 - 8.532	0.459 - 1.269	1.212 ± 0.306	0.862 ± 0.281	0.624 ± 0.189	1.948 ± 0.466	0.691 ± 0.213	1.124 ± 0.341	1.370 ± 0.311	1.637 ± 0.425	0.647 ± 0.166	0.625 ± 0.230	0.650 ± 0.234	1.251 ± 0.302
Potassium- 40	pCi/ g	13.58 - 41.36	32.29 - 43.93	20.41 - 39.02	1.998 - 4.536	6.800 ± 2.056	5.635 ± 2.217	7.661 ± 1.801	10.901 ± 2.609	8.762 ± 2.095	7.842 ± 2.539	8.958 ± 2.085	8.378 ± 2.978	5.874 ± 1.622	5.248 ± 1.728	5.302 ± 1.899	12.52 ± ± 2.48
Radium- 226	pCi/ g	3.159 - 12.53	2.673 - 9.612	3.051 - 8.289	0.459 - 1.323	1.115 ± 0.280	0.844 ± 0.268	0.667 ± 0.156	1.614 ± 0.379	0.645 ± 0.192	1.324 ± 0.341	1.247 ± 0.280	1.494 ± 0.385	0.397 ± 0.149	0.738 ± 0.173	0.686 ± 0.174	1.033 ± 0.223
Radium- 228	pCi/ g	NA	NA	NA	NA	1.200 ± 0.424	0.910 ± 0.361	0.335 ± 0.181	1.816 ± 0.521	0.994 ± 0.287	1.386 ± 0.406	0.895 ± 0.317	0.765 ± 0.360	0.399 ± 0.182	0.538 ± 0.285	0.345 ± 0.179	1.113 ± 0.360
Thallium- 208	pCi/ g	0.648 - 1.539	1.188 - 1.89	0.972 - 1.539	0.108 - 0.216	0.426 ± 0.134	0.441 ± 0.141	0.129 ± 0.072	0.858 ± 0.324	0.334 ± 0.094	0.544 ± 0.160	0.252 ± 0.113	0.408 ± 0.171	0.226 ± 0.081	0.154 ± 0.088	0.226 ± 0.108	0.390 ± 0.122
Thorium- 234	pCi/ g	NA	NA	NA	NA	1.221 ± 2.942	1.928 ± 1.189	0.587 ± 1.012	0.871 ± 1.499	0.637 ± 0.802	2.395 ± 1.340	2.312 ± 2.683	1.736 ± 1.573	0.083 ± 0.140	1.169 ± 3.433	1.357 ± 0.891	2.273 ± 1.873
Uranium- 235	pCi/ g	0.243 - 0.459	0.486 - 1.215	0.324 - 0.756	0.027 - 0.162	0.254 ± 0.164	0.127 ± 0.112	0.107 ± 0.097	0.404 ± 0.158	0.036 ± 0.060	0.117 ± 0.123	0.209 ± 0.106	0.176 ± 0.176	0.040 ± 0.075	0.188 ± 0.105	0.144 ± 0.079	0.126 ± 0.097
Gross Alpha	pCi/ g	NA	NA	NA	NA	9.63 ± 5.63	9.08 ± 5.78	26.3 ± 9.29	10.5 ± 6.62	9.49 ± 5.68	5.67 ± 4.35	10.4 ± 5.82	13.3 ± 7.07	2.70 ± 4.58	13.0 ± 6.40	8.25 ± 5.40	9.58 ± 5.21
Gross Beta	pCi/ g	NA	NA	NA	NA	7.77 ± 3.30	9.11 ± 3.34	22.2 ± 5.50	11.4 ± 4.15	6.53 ± 3.51	5.96 ± 3.01	4.88 ± 3.41	6.61 ± 3.20	9.95 ± 3.95	7.85 ± 3.20	4.24 ± 2.47	12.6 ± 3.96
Thorium- 232	pCi/ g	NA	NA	NA	NA	-	1.39 ± 0.489	-	1.20 ± 0.427	-	-	-	-	0.305 ± 0.207	-	0.433 ± 0.295	-
Uranium- 238	pCi/ g	NA	NA	NA	NA	-	0.701 ± 0.269	-	1.32 ± 0.446	-	-	-	-	0.234 ± 0.138	-	0.348 ± 0.165	-

Note: 1. Identification and Quantification of Radionuclides in Coal Ash, Joint Transportation Research Project for the Indian DOT and Federal Highway Administration