

**DR. MODESTO IRIARTE TECHNOLOGICAL
MUSEUM (FORMER BONUS FACILITY)**

**2018 ANNUAL RADIOLOGICAL SURVEY REPORT -
DRAFT**

**RINCON
PUERTO RICO**

December 2018

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FOR THE PUERTO RICO ELECTRIC POWER AUTHORITY

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2018 ANNUAL RADIOLOGICAL SURVEY REPORT - DRAFT**

RINCON, PUERTO RICO

December 2018

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Puerto Rico Electric Power Authority

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As Subcontractor

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Acronyms and Abbreviations

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
Dome	BONUS Enclosed Domed Building
dpm/100cm ²	disintegrations per minute per 100 centimeters squared
Dup	Duplicate
MDA	Minimum Detectable Activity
MMG	MMG, LLC
NA	Not Applicable
QA	quality assurance
QC	quality control
RCM	Radiological Control Manager
rem	roentgen equivalent in man
RPD	Relative Percent Difference
RWP	Radiological Work Permit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
μR/hour	micro-Roentgen per hour

1.0 INTRODUCTION

MMG, LLC (MMG) conducted the comprehensive annual survey at the Dr. Modesto Iriarte Technological Museum (former BONUS Facility) during the dates of 28 – 30 November 2018 with support from PREPA personnel. This survey was conducted in accordance with the Sampling and Analysis Plan (SAP) for the BONUS Facility prepared by the U.S. Department of Energy (DOE) (or DOE contractor) as amended by a 16 January 2001 Memorandum from Webb to Alvarado. The survey was also altered, as presented below in this report, in consideration of the covering of contamination areas/surfaces by paint and/or concrete, the shielding (concrete floor) placed on the Basement Level, the verification survey performed in January 2005 (refer to 22 February 2005 Memorandum entitled: *2004 Annual Survey and Verification Survey for Basement Floor*), and subsequent annual surveys. This report is organized in accordance with Section 6.2 of the SAP. The sampling and inspection results are discussed below.

Action Levels/Limits

The following action levels/limits are referenced in the BONUS Radiological Control (RADCON) Manual and represent the most conservative, applicable limits:

- **Dose Limits:** The RADCON Manual references a Radiological Worker annual dose limit of 5 rem/year/worker, DOE Administrative Control Level of 2 rem/year/person, and the PREPA Administrative Control Level of 0.2 rem/year/person. For purposes of this Annual Report, an Administrative ***Radiological Worker Level of 2 rem/year/worker*** is used for evaluating dose rate measurements. This report also compares dose rate measurements in the Public Access Areas to the ***Visitor Does Limit*** for visitors of the BONUS Facility, which is limited to an annual radiation of ***0.1 rem/year/person***.
- **Contamination Control Levels:** A surface at the BONUS Facility is considered contaminated if either the removable or total radioactivity detected is above the levels below.

Nuclide ^a	Contamination values	
	Removable ^b (dpm/ 100 cm ²)	Total ^c (fixed + removable) (dpm/100 cm ²)
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above. Includes mixed fission products containing ⁹⁰ Sr	<i>1,000 beta-gamma</i>	<i>5,000 beta-gamma</i>

^aValues in this table apply to radioactive contamination deposited on, but not incorporated into, the interior of the contaminated item.

^bThe amount of removable radioactive material per 100 cm² of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency.

^cLevels may be averaged over 1 m² provided the maximum activity in any area of 100 cm² is less than three times the values in this table.

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2.0 PURPOSE

The purpose of this effort was to conduct an annual radiological survey - to ensure that exposure to employees, the public, and the environment to levels of ionizing radiation are as low as reasonably achievable and demonstrate that levels of radioactivity at the facility remain within the criteria that support the basis for continued use as a museum.

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3.0 LOCATION

This sampling and inspection effort focused on the BONUS Enclosed Domed Building (Dome). Surveys and inspections were performed on the (1) exterior of the entombment (concrete monolith where the entombed reactor vessel resides), (2) Main Level, and (3) Basement Level. Table 1 provides a list of specific survey locations.

Table 1. Survey Locations and Results

Sampling Location	Sample Number	Dose Rate (µR/hour)	Total Contamination (dpm/100 cm ²)	Removable Contamination (dpm/100 cm ²)	Comments
Routine Sampling					
Pipe Chase Face	1	5	<MDA	<MDA	Monolith Top
Pipe Chase Face	2	5	<MDA	<MDA	Monolith Top
Pipe Chase Face	3	4	<MDA	<MDA	Monolith Top
Pipe Chase Face	4	4	<MDA	<MDA Dup=<MDA	Monolith Top
Top Plug Face #1	5	6	<MDA	<MDA	Monolith Top
Top Plug Face #1	6	5	778	<MDA	Monolith Top
Top Plug Face #1	7	4 Dup=6	<MDA	<MDA	Monolith Top
Top Plug Face #2	8	6	<MDA	<MDA	Monolith Top
Top Plug Face #2	9	6 Dup=7	889	<MDA	Monolith Top
Top Plug Face #2	10	6	<MDA	<MDA	Monolith Top
Top Plug Face #3	11	6	741	<MDA	Monolith Top
Top Plug Face #3	12	6	<MDA	<MDA	Monolith Top
Top Plug Face #3	13	6	<MDA	<MDA	Monolith Top
Top Plug Face #4	14	5	<MDA	<MDA	Monolith Top
Top Plug Face #4	15	6	<MDA	<MDA	Monolith Top
Top Plug Face #4	16	5	<MDA	<MDA	Monolith Top
Top Plug Top Surface	17	4	<MDA Dup=<MDA	<MDA	Monolith Top
Top Plug Top Surface	18	4	<MDA	<MDA	Monolith Top
Top Plug Top Surface	19	4	<MDA	<MDA	Monolith Top
Main Floor Water Column	20	6	<MDA	<MDA	Main Level-Controlled Area
Main Floor Water Column	21	5	926	<MDA	Main Level-Controlled Area
Instrument Thimble #1	22	4	<MDA Dup=<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #2	23	4	<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #3	24	4	<MDA	<MDA	Main Level-Controlled Area
Pipe Chase Ext Hatch	25	5	<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #4	26	5	<MDA	<MDA	Main Level-Controlled Area
Fuel Pool Purif. Floor, area	27	17 Dup=17	12,451	<MDA	Main Level-Controlled Area
Fuel Pool Purif. Floor, area	27A	4	<MDA	<MDA	Main Level-Controlled Area. Taken to define elevated area associated with 27 and 28.

Table 1 (Continued)

Sampling Location	Sample Number	Dose Rate (μR/hour)	Total Contamination (dpm/100 cm ²)	Removable Contamination (dpm/100 cm ²)	Comments
Routine Sampling (Continued)					
Fuel Pool Purif Floor, area	27B	4	815	<MDA	Main Level-Controlled Area. Taken to define elevated area associated with 27 and 28.
Fuel Pool Purif. Floor (CM005)	28	14	57,807 Dup=58,325	<MDA	Main Level-Controlled Area
Side of Liq. Waste Ret. Tank #1	30	15	1,445	<MDA	Basement Level
Side of Liq. Waste Ret. Tank #2	31	13	1,482	<MDA	Basement Level
F.W. Heater Room (Wall)	40A	15 Dup=15	4,817 Dup=5,077	<MDA	Basement Level
F.W. Heater Room (Wall)	40B	11	926	<MDA	Basement Level
Vapor Sphere Room	42	5	<MDA	<MDA	Basement Level
Vapor Sphere Room	43	4	<MDA	<MDA	Basement Level
Condenser Room Entry Wall (Block)	50A	5	<MDA	<MDA	Basement Level
Condenser Room Entry Wall (Concrete)	50B	6	<MDA	<MDA	Basement Level
Additional Sampling Locations					
Main Floor-Zone 1	65	6	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 2	66	7	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 3	67	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 4	68	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 5	69	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 6	72	6	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 7	73	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 8	74	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 9	75	5	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 10	76	4	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 11	77	6	NA	<1000dpm/100c m ²	Main Level-Public Access. Masslin Smear

Table 1 (Continued)

Sampling Location	Sample Number	Dose Rate (μR/hour)	Total Contamination (dpm/100 cm ²)	Removable Contamination (dpm/100 cm ²)	Comments
Additional Sampling Locations (Continued)					
Main Floor-Zone 12	78	5	NA	<1000dpm/100cm ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 14	79	5	NA	<1000dpm/100cm ²	Main Level-Public Access. Masslin Smear
Main Floor-Zone 13	80	5	NA	<1000dpm/100cm ²	Main Level-Public Access. Masslin Smear
Basement Floor-Zone 1	70	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 2	71	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 3	81	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 4	89	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 5	90	4	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 6	91	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 7	92	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 8	93	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 9	94	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 10	95	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 11	96	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 12	97	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 13	98	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 14	99	6	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 15	100	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 16	101	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 17	102	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Basement Floor-Zone 18	103	5	NA	<1000dpm/100cm ²	Basement Level Masslin Smear
Condensate Pump #1 base	2018-1	14	1,519	<MDA Dup=<MDA	Basement Level
Condensate Pump #2 dust	2018-2	14	3,446	<MDA	Basement Level

Table 1 (Continued)

Sampling Location	Sample Number	Dose Rate (μR/hour)	Total Contamination (dpm/100 cm ²)	Removable Contamination (dpm/100 cm ²)	Comments
Additional Sampling Locations (Continued)					
Condensate Pump #2 dust separated	2018-3	NA	1,779 ^a	<MDA	Basement Level
Condensate Pump #2 dust at base	2018-4	NA	2,631	<MDA	Basement Level
Quarterly Point 65-Main Floor	65-Q	5	<MDA	<MDA	Main Level – Public Access
Quarterly Point 66-Main Floor	66-Q	6	<MDA	<MDA	Main Level – Public Access
Quarterly Point 67-Main Floor	67-Q	6	<MDA	<MDA	Main Level – Public Access
Quarterly Point 68-Main Floor	68-Q	6	<MDA	<MDA	Main Level – Public Access
Quarterly Point 69-Main Floor	69-Q	5 Dup=5	<MDA Dup=<MDA	<MDA Dup=<MDA	Main Level – Public Access
Location 40A-Back of Probe	40A-1	NA	4,118	NA	Basement Level

dpm/100 cm² = disintegrations per minute per 100 centimeters squared
 Dup = Duplicate
 Fig. = Figure

MDA = Minimum Detectable Activity
 NA = Not Applicable
 μR/hour = micro-Roentgen per hour

^aDust at base of pump was placed on paper and counted directly and separate from pump in a background area (debris was returned to the pump location).

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4.0 PHYSICAL CONDITION

Appendix C provides a copy of the facility inspection checklist used during the annual survey. Findings and observations are provided below.

- **Site Surveillance Features:** Asphalt of the access road and parking area remains in fair and usable condition. There is some broken asphalt, but it is still functional. The entrance gate's motor is not operational; however it is manually operated by the attending guard (Appendix A, Figure 39). The security guard controlled access into the gated facility on each day of the site visit and kept a sign-in log of visitors. The fence surrounding the property was damaged by falling trees during the 2017 hurricane season at approximately six locations totaling approximately 100-ft in length (Appendix A, Figure 36). Recommend removing fallen trees and engaging a fencing contractor to repair the sections of damaged fence. The Dome monolith plaques are in good condition – no change.
- **Dome-Entombed Concrete Monolith and Monolith Penetrations:** Inspection of the Concrete Monolith area revealed superficial cracks throughout the surface of the structure (Appendix A, Figure 3) – no change from past inspections. Superficial cracks are also present along the base of the “top plug” of the concrete monolith top, but with no change from past inspections. All dose rate measurements taken around the structure were not significantly different from background measurements taken. No immediate action is necessary. Additional absorbent clothes have been placed to collect oil/grease dripping from the crane system above (Appendix A, Figures 1 and 2). It is recommended that absorbent clothes continue to be placed at those locations where oil/grease is accumulating on the Concrete Monolith and, especially, if/after the crane is moved.
- **Dome-External Piping Systems:** Inspection of accessible external piping systems revealed no significant indications of deterioration. Outfall pipes on the west side of the property (on the beach outside of perimeter fence) were inspected (Appendix A, Figure 34). Outfall pipes on the south side of the property (outside of perimeter fence) could not be accessed due to overgrown vegetation. One of the drainage pipes on the west side, where it passes under the main access road, is significantly obstructed with silt and debris – likely due to the 2017 hurricane season (Appendix A, Figure 35). It is recommended that the accumulated silt and debris be removed.
- **Dome-Basement Level:** Historically, corrosion was evident on all metal surfaces within approximately 6 in. of the floor, including contaminated surfaces. However, the concrete floor cover (installed in late 2004) covers all floor areas and bases of metallic structures/equipment where surface contamination was present, which is preventing contact with previously accessible contaminated and corroding surfaces. However, a changed condition was noted during the 2018 survey at the location of Condensate Pump #1 and Condensate Pump #2 (Appendix A, Figure 41 and Appendix B, Basement Level Survey Sketch). Loose debris/dust and oil-like substance has accumulated at the base of each pump (refer to Section 6 regarding the contamination survey of this material). Surface fissures/cracks were noted in the concrete floor covering similar to past inspections, but are not of concern. Small patches (less than 1-ft²) of concrete on some Basement Level walls near/at the floor level have also spalled loose from the wall, but do not appear to have compromised the structural integrity of the walls.

On the concrete flooring and structural steel near Sample Locations 50A and 50B, significant corrosion and concrete spalling was noted in previous surveys. PREPA personnel applied some anti-corrosive coating in 2017, which appears to have stabilized the area (Appendix A, Figure 31). It is recommended that the anti-corrosive compound continue to be applied during quarterly surveys, as needed. Also near Sample Locations 50A and 50B, it was noted that absorbent clothes continue to be used to capture oil/lubricant dripping from area/overhead equipment (Appendix A, Figure 24). It is recommended that absorbent clothes continue to be placed at these locations during quarterly surveys, as needed.

Control measures (fixed with paint and concrete layer in some places), which were previously implemented, were inspected (Appendix A, Figures 26, 28, 29, and 30). PREPA personnel applied a fresh coat of yellow paint since the 2016 survey on the Liquid Water Retention Tanks per previous recommendations. The concrete wall coating at Sample Locations 40A and 40B is showing signs of cracking and deterioration, but remains effective. Ongoing and routine assessment of accessible surfaces in the basement is recommended to evaluate the continued effectiveness of the concrete cover flooring and control measures (e.g., paint) emplaced on previous contamination areas. Although immediate action is not critical, it is recommended that an additional layer of concrete be placed over Sample Locations 40A and 40B within the next two years (Appendix A, Figure 30). Access to areas with historical removable contamination is being effectively controlled.

Access to stairways leading to the Basement Level is being effectively maintained and controlled (Appendix A, Figure 13). No action is necessary.

- **Dome-Basement Level Flooding:** Inspection of this level revealed no standing water on the floors. Storm water drains appear to be functioning properly, but silt/mud remains in the sump from historical events (Appendix A, Figure 27).

The gasket around the exterior base of the Dome, which is at ceiling level of the basement, remains intact and effective (Appendix A, Figure 25). The gasket is showing signs of weathering and surficial cracks (repeat from 2016) in the low areas of the gasket where it holds rain water and dries in the sun (Appendix A, Figure 37). The drains in the trough below the gasket are clear and draining rain water properly (Appendix A, Figure 38). The large bay door at the Basement Level remains sealed with expanding foam to prevent rainwater infiltration into the Basement Level. It is recommended that, when the gasket around the base of the Dome is replaced, the gasket is installed in a manner that does not retain rain water.

- **Dome-Main Level:** The Main Level (Controlled Area) is that portion of the Main Level that is not accessible to the public (Appendix A, Figures 16 through 20). The two historical contamination sites remain covered with floor tiles; the tile work is in good condition and is effective in reducing the dose levels. One area adjacent to the north side of the Monolith is also covered with lead bricks, which is effective in reducing elevated dose rate levels in this area (Appendix A, Figure 21). Ongoing and routine assessment of the floor tile and lead bricks in this area is recommended. There is also no discernible evidence of work and/or damage affecting the control measures (floor tiles) on the Main Level, Museum Area (Appendix A, Figures 4 through 10 and 14). The safety guard along the railing (Appendix A, Figure 17), which protects from falls to the Basement Level below, is in good condition and access control signs are properly placed along the railing. The pad lock on the gate within the railing system, which provides access from the

Museum Area to the Controlled Area, was in place and locked (Appendix A, Figure 15). The PREPA team will continue to monitor the tiles within the Museum Area for signs of cracks/failures.

Evidence of termites (termite frass) was observed (repeat from 2015 and 2016) on the east side of Main Level (Museum Area) where plywood walls were constructed in recent years (Appendix A, Figure 22). No new/additional termite frass was observed during the 2018 survey/inspection – no action necessary.

Fire extinguishers throughout the Main Level were inspected and appear to have out-of-date inspections and/or need to be replaced (Appendix A, Figure 23). It is recommended that all fire extinguishers throughout the facility be inspected and corrective actions taken, as necessary.

- **Dome-Mezzanine Level:** Access to ladders and stairways leading to the mezzanine level are being effectively maintained and controlled (Appendix A, Figures 11, 12, and 13). The structure appears sound and in good condition. No immediate action is necessary.
- **Dome-Exterior:** Inspection of the Dome structure did not reveal any significant structural discrepancies. The Dome structure exterior was re-sealed and painted before the 2015 annual survey. This coating appears to have suffered some damage on the south side due to the 2017 hurricane season (Appendix A, Figure 32). Both entrance portals are in good condition and it appears that roof repairs have been made on the roof above the southern portal where evidence of leaks were noted during the 2016 survey (Appendix A, Figure 42).
- **Surrounding Land:** Inspection the surrounding land within approximately 0.25 miles of the site revealed that a trail bike course has been established primarily in the eastern and northern portions of the property (outside the fenced area surrounding the BONUS Facility). PREPA personnel indicate that the bike trail was allowed to be established for one-time event. Also, it appears that a small outbuilding on the northern side of the property (outside the BONUS Facility fence) is frequented by visitors to the beach as is evidenced by a fairly new mattress found in the structure. The beach immediately adjacent to the site continues to be a popular surfing location. The adjacent lighthouse and surrounding scenic overlook continues to be a popular place for the local population and vacationers to watch the sun set. The surrounding land uses have not significantly changed and do not appear to be a site security/access issue to the BONUS Facility. No immediate action is necessary.
- **General Site Upkeep:** The general condition of the ancillary buildings has not significantly changed. However, previous recommendations regarding roofing repairs and termite treatment have been completed. It is recommended that pest control inspection/treatment and roof repairs continue to be administered, as needed, at the BONUS Facility and ancillary buildings.
- **Site Security:** A security guard was present at all times during the survey. No immediate action is necessary.
- **Erosion:** Inspection of the surrounding property and slopes to the beach revealed no significant changes or signs of excessive erosion. Dense vegetation on the slopes from the facility to the beach appears to be effectively controlling erosion. No immediate action is necessary.

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5.0 DIRECT RADIATION MONITORING

Table 1 (Section 3) presents direct radiation monitoring results for this survey. Appendix B provides survey records and sketches depicting survey locations for the direct radiation monitoring conducted during this annual comprehensive survey. Direct radiation measurements were taken with a Ludlum Micro-R Meter, Model 19, at 30 cm from the source or survey location. Table 2 summarizes these results.

Table 2. Summary of Direct Radiation Monitoring Results

Location	Dose Rate at 30 cm from Source ($\mu\text{R}/\text{hour}$)			Expected Exposure Rate ^a		Annual Dose Limits (rem/year)	
	Min. ($\mu\text{R}/\text{hour}$)	Ave. ($\mu\text{R}/\text{hour}$)	Max. ($\mu\text{R}/\text{hour}$)	Max. Exposure (hour/year)	Rate (rem/year)	Rad Worker	Visitor
Monolith Top	4	5.2	7	416	<u>0.003</u>	<u>2</u>	NA
Main Level (Controlled Area)	4	8.1	17	416	<u>0.007</u>	<u>2</u>	NA
Main Level (Public Access)	4	5.6	7	2,080 (employee)	<u>0.015</u>	<u>2</u>	NA
				832 (visitor)	<u>0.006</u>	NA	<u>0.1</u>
Basement Level	4	7.3	15	416	<u>0.006</u>	<u>2</u>	NA

rem = roentgen equivalent in man

^aBased conservatively on the maximum-recorded dose rate at a conservative exposure scenario. For example, exposure level for the Monolith top would be $7 \mu\text{R}/\text{hour} \times (1 \text{ rem}/1,000,000 \mu\text{R}) \times (8 \text{ hours}/1 \text{ week}) \times (52 \text{ weeks}/1 \text{ year}) = 0.003 \text{ rem}/\text{year}$.

The results summarized in the Table 2 indicate that there are no Radiation Areas in the BONUS Facility as defined in Title 10 Part 835 of the Code of Federal Regulations (10 CFR 835), which is 0.005 rem/hour at 30 cm or 5,000 $\mu\text{R}/\text{hour}$ at 30 cm for the dose rate measurements conducted at BONUS). The highest dose rates recorded at 30 cm in the BONUS Facility are well below the limit defining a radiation area. The radiation levels exhibited throughout the facility do not approach annual dose limits for radiological workers or site visitors based on conservative exposure scenarios summarized in the table above.

Instrument calibrations and daily response check records are maintained at the BONUS facility. Appendix D also provides a copy of instrument calibration sheets and relevant daily response checks. Duplicate field measurements were also made at a rate of 5% of the routine measurements and are summarized in Table 3. All quality assurance (QA)/quality control (QC) checks performed within acceptable limits, except as noted below.

Table 3. Summary of Direct Radiation Monitoring Quality Control

Location	Result (µR/hour)		RPD (%)	Comments
	Initial	Duplicate		
7	4	6	40	Fail ¹
9	6	7	15	Acceptable
27	17	17	0	Very good
69-Q	5	5	0	Very good
40A	15	15	0	Very good

RPD = Relative Percent Difference = $[(\text{Sample} - \text{Duplicate}) / ((\text{Sample} + \text{Duplicate}) / 2)] \times 100$

¹New PREPA personnel were participating in the annual survey and this discrepancy was observed by Mr. Webb as an operator error caused by taking a reading before the needle had stabilized. The operator was instructed to repeat a duplicate measurement at Location #9, which show improvement in the operator's technique.

6.0 CONTAMINATION LEVEL MONITORING

Table 1 (Section 3) presents contamination level monitoring results for this survey. Appendix B provides contamination survey records and sketches depicting survey locations for the surface contamination measurements conducted during this annual comprehensive survey. Measurements were taken with a Ludlum 44-9 probe coupled to a Ludlum 2221 Scaler/Ratemeter. Total surface and removable contamination surveys were conducted in accordance with Standard Operating Procedures (SOPs) PBR-11.3.1 and 11.4.1. Contamination level results are summarized below.

Concrete Monolith

There are no radioactive Contamination Areas (as defined in 10 CFR 835) associated with the exterior of the Concrete Monolith structure. Smear samples were collected from the surface of the Concrete Monolith to assess transferable or removable surface beta/gamma contamination. None of the smear samples exhibited removable contamination above the MDA. Three survey locations, 6, 9, and 11 exhibited total surface contamination levels above MDA, but well below the 5,000 dpm/100 cm² action level. All remaining survey locations exhibited total surface contamination levels below the MDA. It is recommended that the Concrete Monolith Top be designated as a Controlled Area due to the historical presence of slightly elevated fixed surface beta/gamma contamination levels and the need to ensure no intrusive work is conducted on the monolith without prior notice. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the Concrete Monolith surface) work is performed on this level without review and approval by the Radiological Control Manager (RCM). Job-specific Radiological Work Permits (RWPs) may be required for any future intrusive work on the Concrete Monolith Top.

Main Level (Controlled Area)

There are no radioactive Contamination Areas associated with the controlled area (inside the railing and Plexiglas) of the Main Level. Smear samples were collected from the floor surface of the Main Level (controlled area) to assess transferable or removable surface beta/gamma contamination. None of the smear samples exhibited removable contamination above MDA. However, four planned survey locations (21, 27, 27B, and 28) had total surface beta/gamma contamination levels above MDA, two of which were above the 5,000 dpm/100 cm² total surface action level (926; 12,451; 815; and 57,807 dpm/100 cm², respectively). It is recommended that the Main Level (controlled area) remain designated as a Controlled Area due to the presence of elevated fixed surface beta/gamma contamination and be marked/posted in accordance with Section 6.7 of SOP PBR-11.1.4 (modify posting to avoid alarming visitors – current posting is acceptable). Administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed in this area without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.

Main Level (Public Access Area)

The Main Level (public access area) was evaluated for transferable/removable surface contamination only (i.e., only smear samples were performed). These results and previous surveys indicate that there are no radioactive Contamination Areas associated with the public access area

(outside the railing and Plexiglas) of the Main Level. Masslin samples (survey locations 65-69 and 72-80) were collected from the floor surface of the Main Level (public access area) to assess transferable or removable surface beta/gamma contamination. Prior to collecting masslin samples, smear samples were also collected from the floor surface of the Main Level (public access area) at five Quarterly Survey locations (Locations 65-Q through 69-Q). Masslin and smear samples exhibited no removable contamination above MDA or 1,000 dpm/100 cm². Historically, fixed surface contamination does exist on the concrete floor of the Main Level (public access area), but has been shielded by the placement of tiles in this area (Appendix A, Figures 4 through 10). Despite the fact that fixed contamination has been shielded with floor tiles, it is recommended that this area remain a Controlled Area. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.

Basement Level

Since the Basement Level floor has been covered with approximately 4-in of concrete, all floor sampling locations on this level were evaluated for transferable/removable surface contamination only (i.e., only smear samples/masslin were performed). Masslin samples (survey locations 70, 71, 81, and 89-103) were collected from the floor surface of the Basement Level to assess transferable or removable surface beta/gamma contamination. Masslin smear samples exhibited no removable contamination above MDA or 1,000 dpm/100 cm². In addition to the masslin samples performed on the floor throughout the level, total and removable contamination was assessed on other surfaces (other than floor) that have been covered with paint and/or concrete due to historical removable contamination (planned survey locations 30, 31, 40A, 40B, 50A, and 50B. None of the smear samples from these locations exhibited removable contamination above MDA. However, one of these survey locations, the duplicate for 40A, had total surface beta/gamma contamination levels above the 5,000 dpm/100 cm² action level (5,077 dpm/100 cm²). An additional measurement was made at 40A with the screen of the detector probe facing away from the surface in order to screen out beta surface contamination (location 40A-1), which resulted in a reading of 4,118 dpm/100 cm². This result indicates that the majority of total survey contamination at location 40A is can be attributed to gamma contamination. Additionally, three survey locations, 30, 31 and 40B, exhibited a total surface contamination level above MDA, but well below the 5,000 dpm/100 cm² action level.

Two additional survey locations (42 and 43) were evaluated in the Vapor Sphere Room where a tank was historically used for radioactive waste/material storage (a sign indicating radioactive material storage was also present on the door). These survey locations were taken from on top of the newer concrete floor. Both removable and total surface readings at these two locations were below MDA.

During a visual survey of the Basement Level, accumulation of oil-like substance and corrosive debris where observed at Condensate Pump #1 and #2 on the east side of the basement (Appendix A, Figure 41). Total surface beta/gamma readings and smear samples were performed at 2018-1 (base of Condensate Pump #1) and 2018-2 (base of Condensate Pump #2). Total surface beta/gamma contamination levels were 1,519 and 3,446 dpm/100 cm² for Condensate Pumps #1 and #2, respectively. Although the transferable/removable surface contamination results at these

two locations resulted in no removable contamination above MDA, loose/removable material was observed to be present on the surface of the base of each pump. Some loose debris from Condensate Pump #2 (from an approximate 100 cm² area) was placed on a sheet of paper (sample location identifier 2018-3) and counted in a background area, with a result of 1,779 dpm/100 cm² removable beta/gamma contamination). A direct surface reading was re-performed at the base of Condensate Pump #2, where the debris was removed, with a result of 2,631 dpm/100 cm² total surface beta/gamma contamination.

Recommendations for access control and posting of the Basement Level are provided below:

- Proposed public access area in Basement Level – Despite the fact that fixed contamination has been shielded with the added concrete flooring in the basement, it is recommended that the proposed public access area in the Basement Level remain designated as a controlled area. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.
- Proposed non-public access area in the Basement Level – Despite the fact that elevated removable surface contamination levels have been fixed through control measures, it is recommended that the proposed non-public access areas in the Basement Level remain designated as a controlled area and be marked/posted in accordance with Section 6.7 of SOP PBR-11.1.4 (modify posting to avoid alarming visitors). The non-public access areas are those portions of the Liquid Waste Pump Room/F.W. Heater Room and Retention Tank Room that will be partitioned off as “no public access”. Those portions of these rooms that will allow public access will be controlled as stated in the previous bullet. Administrative procedures should be in place to ensure that no intrusive (disturbing the floor or wall surfaces) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area. Re-application of the yellow paint on the liquid retention tanks (Appendix A, Figure 30) is recommended since the paint is showing signs of wear, historical smear samples (prior to painting) resulted in removable contamination above MDA, and elevated total surface level remain (e.g., sample locations 30, 31, and 30A-1).
- Additional non-public access area in the Basement Level – Conditions at Condensate Pumps #1 and #2 warrant posting as a Contamination Area (temporary posting was accomplished via rope and signage during the 2018 Annual Survey [Appendix A, Figure 42]). It is recommended that a RWP be prepared for general entry/exit of the area for visual inspection and performing annual/quarterly survey measurements. Administrative procedures should be in place to ensure that no other work (beyond the activities covered under the general access RWP) is performed on this level without review and approval by the RCM. Job-specific RWPs will be required for any future intrusive work in this area. It is further recommended that U.S. Department of Energy responsible persons be engaged to address the condition associated with Condensate Pumps #1 and #2 (e.g., removal/disposal of loose debris and entombment of the pumps).

Contamination Survey QA/QC

Instrument calibration records and daily response check records (pre- and post-survey daily checks) are maintained at the BONUS facility. Appendix D also provides a copy of instrument calibration records and relevant daily response checks. Duplicate field measurements were also made at a rate of 5% and are summarized in Table 4. All QA/QC checks performed within acceptable limits.

Table 4. Summary of Contamination Level Monitoring Quality Control

Location	Result (dpm/100 cm ²)		RPD (%)	Comments
	Initial	Duplicate		
4 (Removable)	<MDA	<MDA	NA	Good
17 (Total Surface)	<MDA	<MDA	NA	Good
22 (Total Surface)	<MDA	<MDA	NA	Good
28 (Total Surface)	57,807	58,325	0.9%	Very Good
69-Q (Total Surface)	<MDA	<MDA	NA	Good
69-Q (Removable)	<MDA	<MDA	NA	Good
40A (Total Surface)	4,817	5,077	5.3%	Good
2018-1 (Removable)	<MDA	<MDA	NA	Good

$$RPD = [(Sample - Duplicate) / ((Sample + Duplicate) / 2)] \times 100$$

7.0 LABORATORY DATA

There were no radiological laboratory data generated to support this survey.

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8.0 SUMMARY OF RECOMMENDATIONS

Based on previous surveys and the 2016 Annual Survey results presented above, the following recommendations are provided:

- No “general” RWPs are required for non-intrusive, routine activities (surveys, tours, etc.) at the Facility. Activities that may disturb floors, walls, and/or other potentially contaminated surfaces should be written in a brief planning document and submitted to the RCM for review. As noted in the bullets below, job-specific RWPs may be required for any future intrusive work in the facility.
- Physical Condition:
 - Falling trees damaged the fence surrounding the property during the 2017 hurricane season at approximately six locations totaling approximately 100-ft in length (Appendix A, Figure 36). Recommend removing fallen trees and engaging a fencing contractor to repair the sections of damaged fence.
 - It is recommended that absorbent clothes continue to be placed at those locations where oil/grease is accumulating on the Concrete Monolith and, especially, if/after the crane is moved.
 - One of the drainage pipes on the west side, where it passes under the main access road, is significantly obstructed with silt and debris – likely due to the 2017 hurricane season (Appendix A, Figure 35). It is recommended that the accumulated silt and debris be removed.
 - On the concrete flooring and structural steel near Sample Locations 50A and 50B, significant corrosion and concrete spalling was noted in previous surveys. PREPA personnel applied some anti-corrosive coating in 2017, which appears to have stabilized the area (Appendix A, Figure 31). It is recommended that the anti-corrosive compound continue to be applied during quarterly surveys, as needed.
 - Near Sample Locations 50A and 50B, it was noted that absorbent clothes continue to be used to capture oil/lubricant dripping from area/overhead equipment (Appendix A, Figure 24). It is recommended that absorbent clothes continue to be placed at these locations during quarterly surveys, as needed.
 - Although immediate action is not critical, it is recommended that an additional layer of concrete be placed over Sample Locations 40A and 40B within the next two years (Appendix A, Figure 30).
 - It is recommended that, when the gasket around the base of the Dome is replaced, the gasket be installed in a manner that does not retain rainwater.
 - **Fire extinguishers throughout the Main Level were inspected and appear to have out-of-date inspections and/or need to be replaced (Appendix A, Figure 23). It is recommended that all fire extinguishers throughout the facility be inspected and corrective actions taken, as necessary.**
 - It is recommended that pest control inspection/treatment and roof repairs continue to be administered, as needed, at the BONUS Facility and ancillary buildings.

- **Concrete Monolith:** It is recommended that the Concrete Monolith Top remain designated as a controlled area due to the historical presence of elevated fixed surface beta/gamma contamination levels and the need to protect the integrity of the monolith structure. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the Concrete Monolith surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work on the Concrete Monolith Top.
- **Main Level (non-public access area):** It is recommended that the Main Level (controlled area) remain designated as a controlled area due to the presence of elevated fixed surface beta/gamma contamination and be marked/posted in accordance with Section 6.7 of SOP PBR-11.1.4 (modify posting to avoid alarming visitors – current posting is acceptable). Administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.
- **Main Level (public access area):** Despite the fact that fixed contamination has been shielded with floor tiles, it is recommended that the Main Level (public access area) remain a controlled area. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.
- **Proposed public access area in Basement Level:** Despite the fact that fixed contamination has been shielded with the added concrete flooring in the basement, it is recommended that the proposed public access area in the Basement Level remain designated as a controlled area. Marking/posting of this area is not required; however, administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.
- **Proposed non-public access area in the Basement Level –** Despite the fact that elevated removable surface contamination levels have been fixed through control measures, it is recommended that the non-public access areas in the Basement Level remain designated as a controlled area and be marked/posted in accordance with Section 6.7 of SOP PBR-11.1.4 (modify posting to avoid alarming visitors). The non-public access areas are those portions of the Liquid Waste Pump Room/F.W. Heater Room and Retention Tank Room that will be partitioned off as “no public access”. Those portions of these rooms that will allow public access will be controlled as stated in the previous bullet. Administrative procedures should be in place to ensure that no intrusive (disturbing the floor surface, walls, or control measures) work is performed on this level without review and approval by the RCM. Job-specific RWPs may be required for any future intrusive work in this area.
 - It is recommended that the immediate area surrounding Condensate Pumps #1 and #2 be posted as a Contamination Area within the controlled area of the Basement Level (temporary posting was accomplished via rope and signage during the 2018 Annual Survey [Appendix A, Figure 42]). It is recommended that a RWP be

prepared for general entry/exit of the area for visual inspection and performing annual/quarterly survey measurements. Administrative procedures should be in place to ensure that no other work (beyond the activities covered under the general access RWP) is performed on this level without review and approval by the RCM. Job-specific RWPs will be required for any future intrusive work in this area. It is further recommended that U.S. Department of Energy responsible persons be engaged to address the condition associated with Condensate Pumps #1 and #2 (e.g., removal/disposal of loose debris and entombment of the pumps).

- Per SOP PBR-11.1.4, routine surveys are required to ensure removable contamination remains below action levels. For this purpose and since a changed condition was noted during this 2018 survey, it is recommended that the annual comprehensive survey and quarterly surveys continue to be repeated. Quarterly surveys should focus on public access areas in close proximity to historical removable contamination areas (F.W. Heater Room/Liquid Waste Pump Room and Retention Tank Room).

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APPENDIX A
PHOTOS

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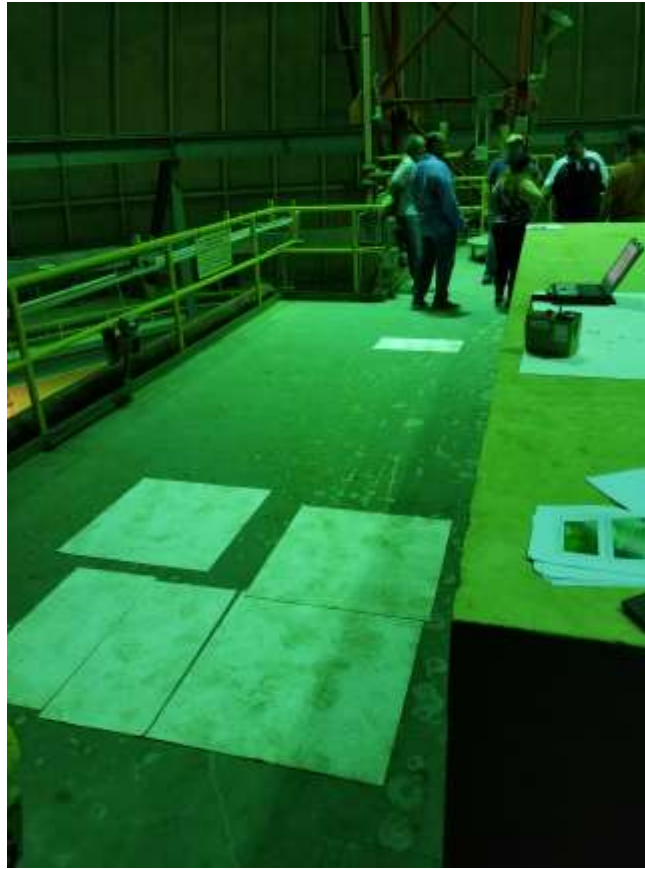


Figure 1. Entombment Top (Top Plug, Northwest Side) – Oil Pads Due to Overhead Crane



Figure 2. Entombment Top – Pad has been Placed to Address Oil Leaking from Overhead Crane (Near Sampling Points 1, 2, 3, and 4)



Figure 3. Entombment Top – Surficial Cracks (Typical)

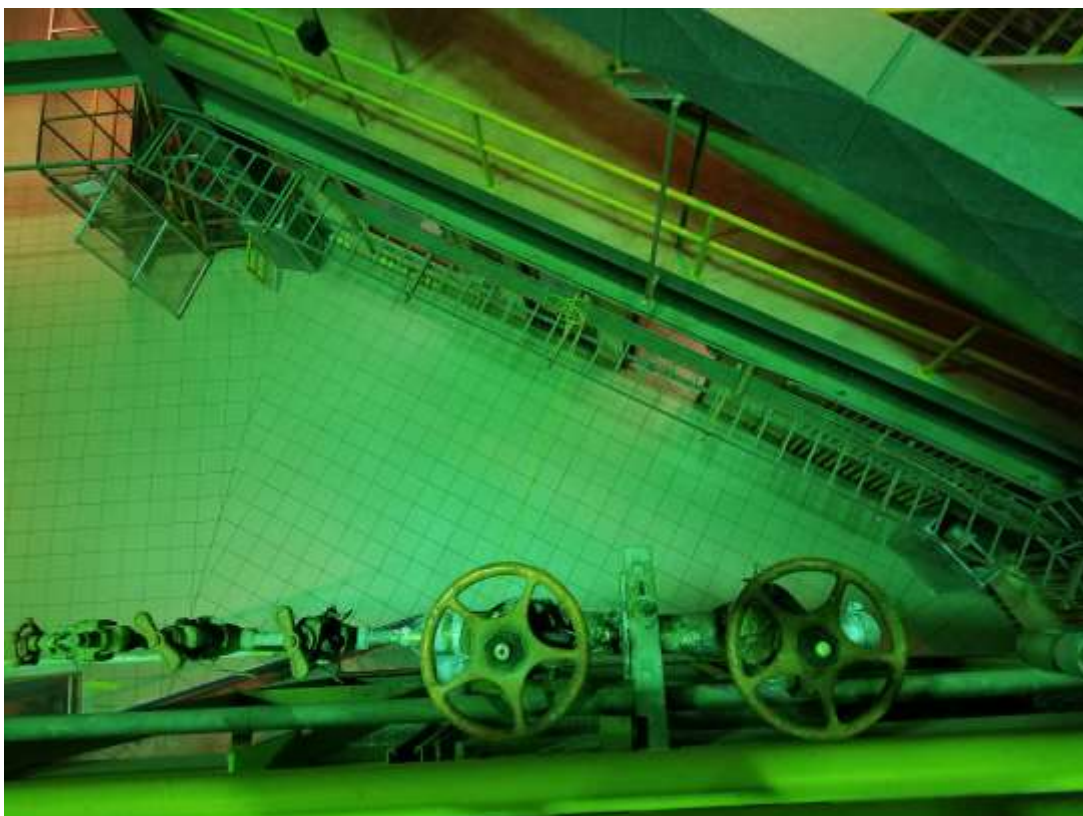


Figure 4. Main Level (Southwest Side) – Overhead View



Figure 5. Main Level (South Side) – Overhead View



Figure 6. Main Level (Southeast Side) – Overhead View



Figure 7. Main Level (East Side) – Overhead View



Figure 8. Main Level (North/Northeast Side) – Overhead View

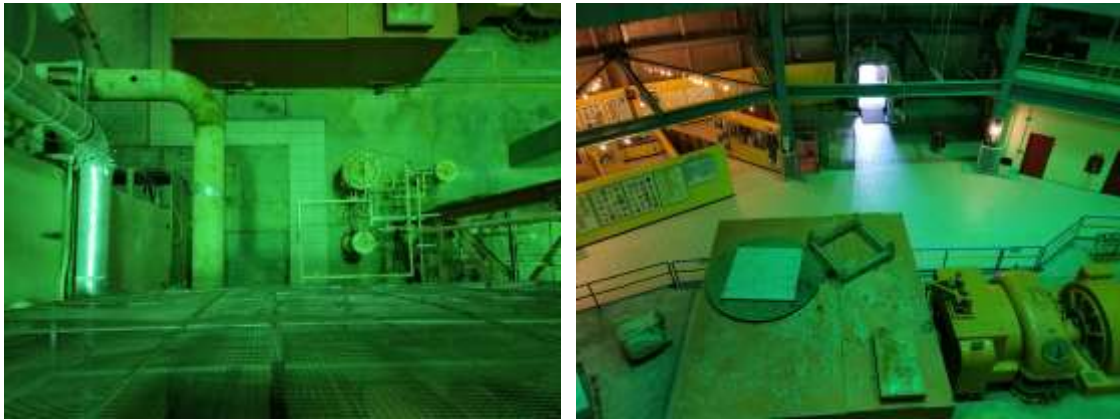


Figure 9. Main Level (North Side) – Overhead View

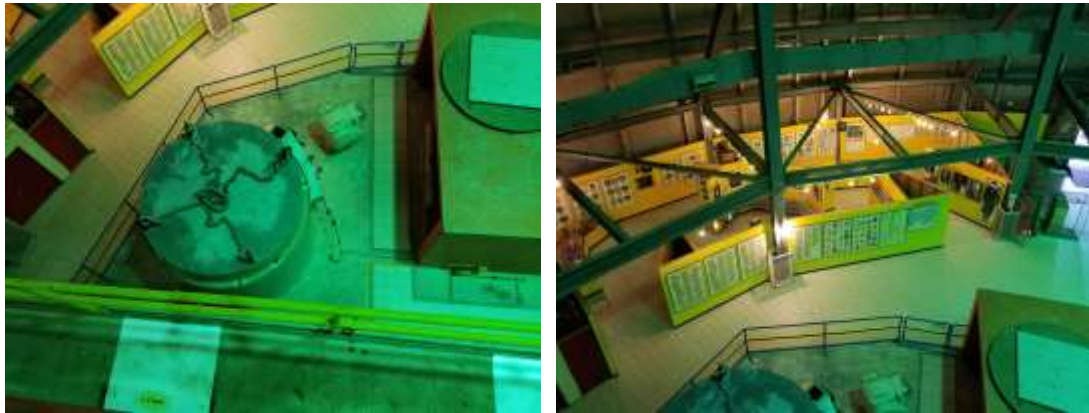


Figure 10. Main Level (Northwest Side) – Overhead View



Figure 11. Main Level – Locked and Controlled Access to East Mezzanine and Electrical Panels



Figure 12. Main Level – Locked and Controlled Access to South Mezzanine



**Historical Radiological
Control Sign**

**Figure 13. Main Level (Museum Area) – Locked and Controlled Access to South Side of
Basement Level (Left) and Mezzanine (Right)**



Figure 14. Main Level (Museum Area) – Locked and Controlled Access to Machine Shop (Left) and Electrical Shop (Right) Former File Storage



Figure 15. Main Level (Controlled Area) – Locked Access from Museum Area to Controlled Area

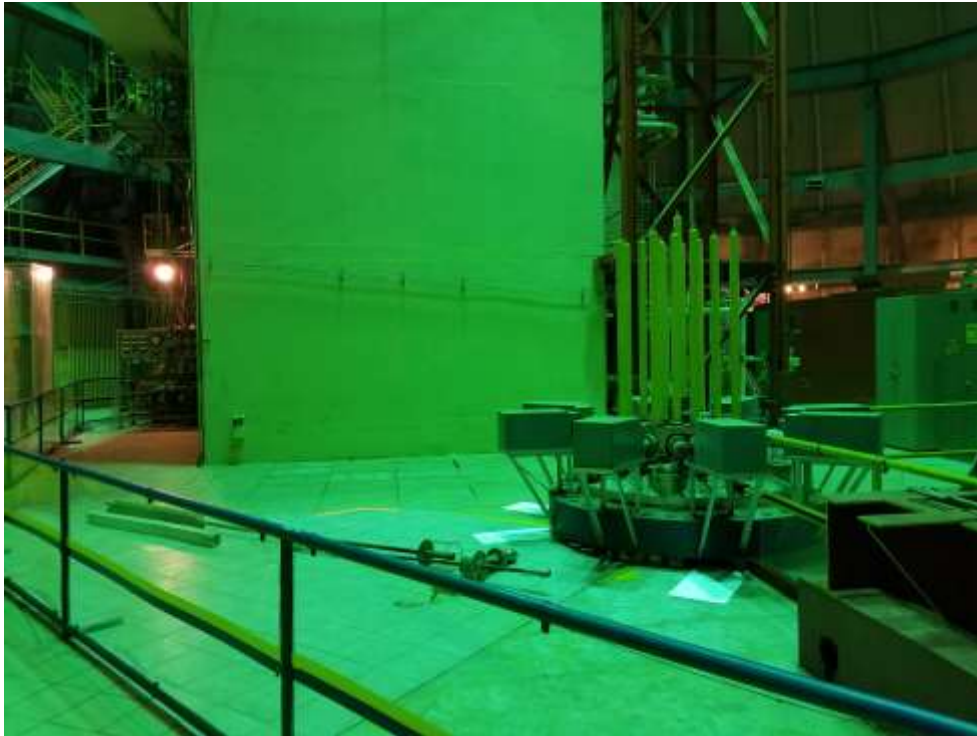


Figure 16. Main Level (Controlled Area) – Southeast Side



Figure 17. Main Level (Controlled Area) – East Side



Figure 18. Main Level (Controlled Area) –Northeast Side



Figure 19. Main Level (Controlled Area) – North Side



Figure 20. Main Level (Controlled Area) – Northwest Side



Figure 21. Main Level (Controlled Area) – Engineering Controls (Concrete, Tiles, and Lead Bricks) in Good Condition



Figure 22. Main Level (Museum Area) – Wood Paneling with Past Evidence of Termites (East Side)

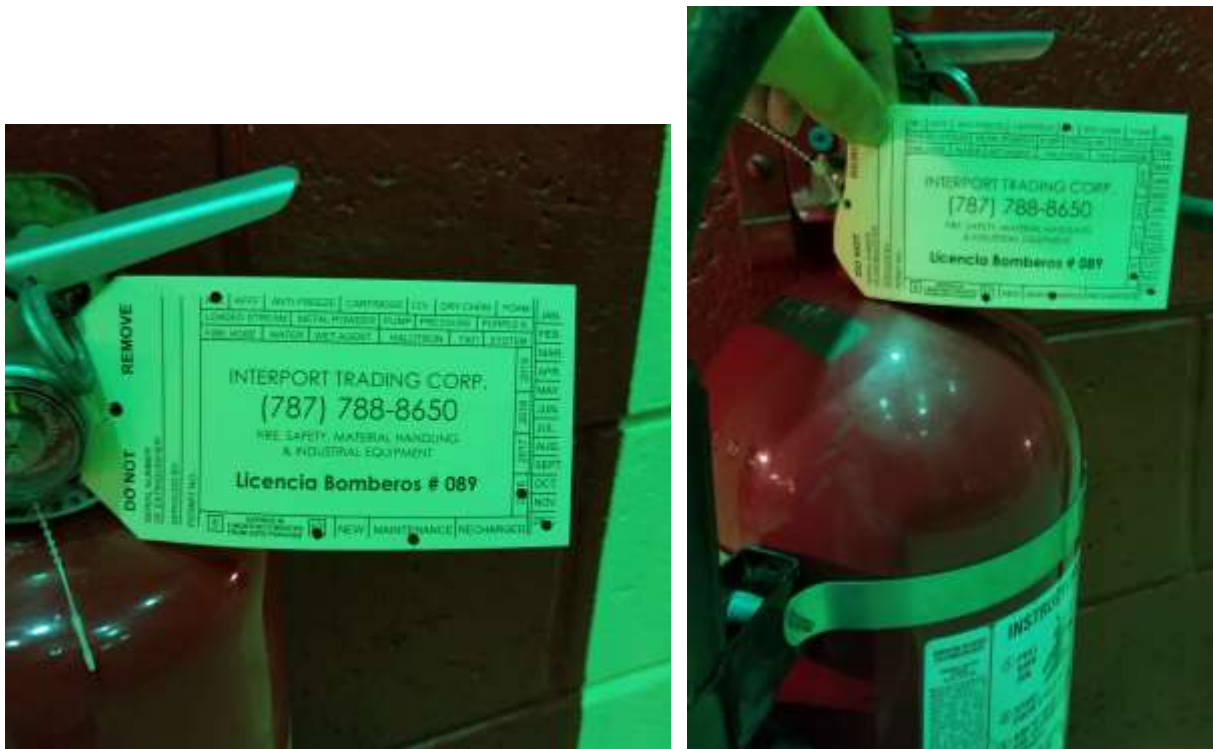


Figure 23. Main Level (Museum and Controlled Areas) – Fire Extinguisher Inspections Out of Date



Figure 24. Basement Level – Oil/Lubricant Spots on Basement Floor from Overhead Equipment



Figure 25. Basement Level – Beneath North Entrance Air Lock (No Signs of Recent Water Infiltration – Older Stains Persist)



Figure 26. Basement Level – Concrete Filled Sink



Figure 27. Basement Level – Lowest Point in Basement with No Standing Water



Figure 28. Basement Level – Sample Locations 40A and 40B Covered by Engineering Control (~1/2 Inch Concrete) with Caution Sign Reading “Controlled Area – Hand and Foot Frisking Required Upon Exit”



Figure 29. Basement Level – Painted Flange (Engineering Controls) at Former Decontamination Sink Location



Figure 30. Basement Level – Sample Locations #30 and #31 on Liquid Waste Retention Tanks with Engineering Control (Yellow Paint) – Showing Signs of Wear

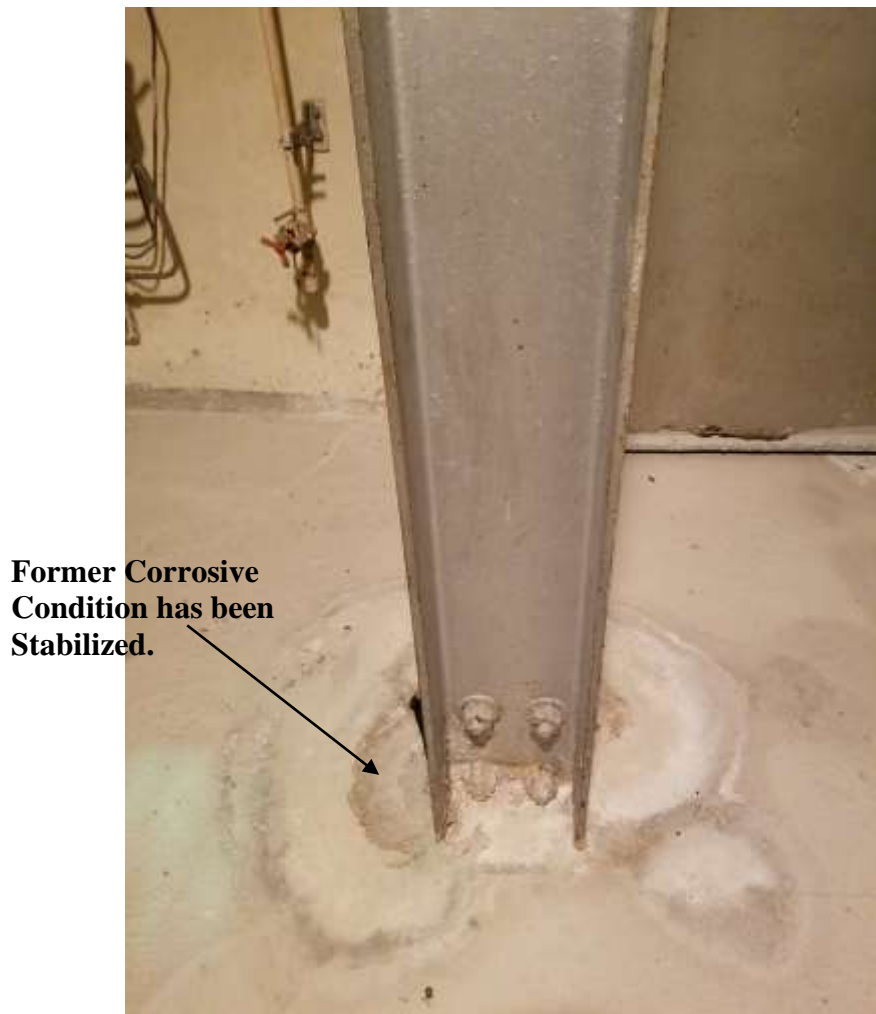


Figure 31. Basement Level – Corrosion Issues on Concrete Floor near Sample Locations 50A and 50B – Was Treated and Has Stabilized



**Damage
from 2017
Hurricane
Season**

Figure 32. Dome Structure – Exterior with Protective Coating and Paint



Figure 33. Dome Structure – Interior with Fire Suppression Piping



Figure 34. Dome Structure – Drainage Outfall Points and Ditches (Southern Outfall)



**Debris Blocking Pipes
on East Side of Road**



Figure 35. Dome Structure – Drainage Outfall Points and Ditches (Under Main Access Road –East side of road – right pipe filled with sand and debris)



Figure 36. Fence –Fencing and Perimeter – 2017 Hurricane Season Damaged Several Sections of Fencing (Approximately 100-ft Total Length)



Figure 37. Dome Structure – Flexible Gasket/Seal – Dome Perimeter



Figure 38. Dome Structure – Rain Trough Below Flexible Gasket/Seal (Drain is Free of Debris)



Figure 39. Security – Main Gate in Good Working Condition (Manual Open/Close)



Figure 40. Ancillary Buildings and Structures – Guard Shack



Condensate Pump #1

Condensate Pump #2

Figure 41. Basement Level – Changed Conditions at Condensate Pumps #1 and #2



Figure 42. Basement Level – Temporary Posting

APPENDIX B
ANNUAL SURVEY CONTAMINATION SURVEY FORMS AND SKETCHES

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TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1345 hrs Task Number N/A

Specific Area of Survey: Entombed Building-North Side MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts)})/E) \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A= $(Sample-Bkg)/E \times CF$

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/18 ⁷⁹	44-9	154535	8/2/18 ¹⁹	18 %	1012	51	686
** Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19 ^{11/28/18}	18 %	1012	40	609

SURVEY DATA		Survey Map Attached <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
1	North Side	N/A	42	N/A	<MDA
2	North Side	N/A	56	N/A	<MDA
3	North Side	N/A	55	N/A	<MDA
4	North Side	N/A	50	N/A	<MDA
** 24	North Side	N/A	35	N/A	<MDA
** 26	North Side	N/A	35	N/A	<MDA
NA	NA	N/A	NA	N/A	NA

Survey Technician: C. Webb
 Reviewed By: Stephen Capodemo

** Separate background reading was performed for locations 24 and 26. One Entombment top level background was used for #1-#4 and a Main Floor level background was used for #24 and #26.

$$CPM_{Sample} = \frac{A \cdot E}{CF} + Bkg$$

$$= \frac{686 \cdot 0.18}{6.67} + 51$$

$$\approx 69.5 \text{ CPM} \approx MDA$$

TECHNOLOGICAL MUSEUM DR, MODESTO IRIARTE BEAUCHAMP
(former BONUS REACTOR FACILITY) Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 1310 hrs Date: Yr 18 Mo 11 Dy 28

Task: Comprehensive Survey RWP: NA

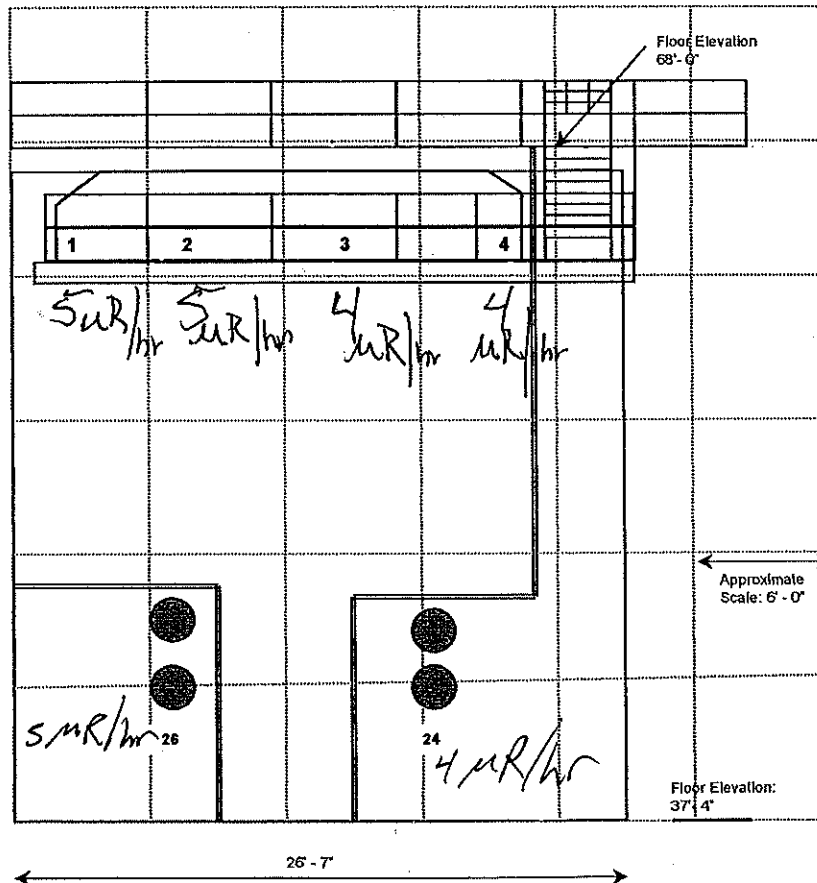
Map key: ° = Sample Location □ = Air Sampler Location __ = Core Sample

Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: North Side

Sketch: **Entombment System - North View**

1 = Sample Locations



Instruments (Model and Serial Numbers): Model 19 148190

Survey Technician(s): Freddie Rodriguez

Reviewed by: Stephen Castellano

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1400 hrs Task Number N/A

Specific Area of Survey: Entombed Building - North West Side ^{Top} ^{CW} 11/28/18 MDA= $((2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg+Bkg/Ts}))/E \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E x CF

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/18 ¹⁹	44-9	154535	8/2/19	18 %	1012	51	686
<u>NA</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>	<u>NA</u> %	<u>NA</u>	<u>NA</u>	<u>NA</u>

SURVEY DATA		Survey Map Attached <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
5	Top Plug Face	N/A	64	N/A	<MDA
6	Top Plug Face	N/A	72	N/A	778
7	Top Plug Face	N/A	61	N/A	<MDA
8	Top Plug Face	N/A	59	N/A	2MDA
9	Top Plug Face	N/A	75	N/A	889
10	Top Plug Face	N/A	61	N/A	<MDA
11	Top Plug Face	N/A	71	N/A	741
12	Top Plug Face	N/A	63	N/A	<MDA
13	Top Plug Face	N/A	65	N/A	<MDA
14	Top Plug Face	N/A	67	N/A	<MDA
15	Top Plug Face	N/A	61	N/A	<MDA
16	Top Plug Face	N/A	58	N/A	<MDA
17	Top Plug - Top Surface	N/A	51	N/A	<MDA
18	Top Plug - Top Surface	N/A	57	N/A	<MDA
19	Top Plug - Top Surface	N/A	45	N/A	<MDA
17Dup	Duplicate	N/A	50	N/A	<MDA

Survey Technician: C. Webb
 Reviewed By: Stephen G. Williams

*MDA is total in dpm/100 cm²

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 13:30 Date: Yr 2019 Mo 08 Dy 28

Task: Comprehensive Survey RWP: NA

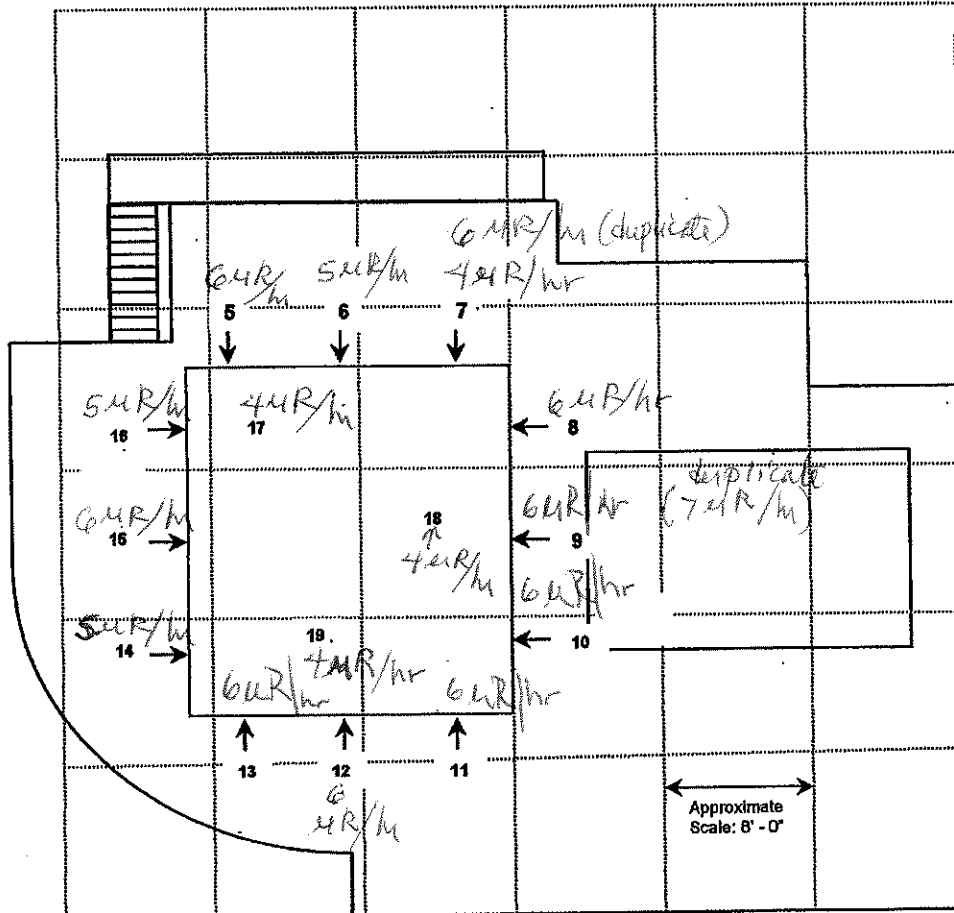
Map key: ○ = Sample Location □ = Air Sampler Location _ = Core Sample

Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: Entombment System – Top (Plan View)

Sketch:

1' = Sample Locations



Instruments (Model and Serial Numbers): Model 19 / 148190 S/N

Survey Technician(s): Freddie Rodriguez

Reviewed by:
Stephen G. Holcomb

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1500 hrs Task Number N/A

Specific Area of Survey: Entombed Building-South Side MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts)})/E) \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E x CF

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1012	40	609
<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i> %	<i>NA</i>	<i>NA</i>	<i>NA</i>

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
22	South Side	<i>N/A</i>	31	<i>N/A</i>	<MDA
22Dup	Duplicate	<i>N/A</i>	37	<i>N/A</i>	<MDA
<i>NA</i>	<i>NA</i>	<i>N/A</i>	<i>NA</i>	<i>N/A</i>	<i>NA</i>

Survey Technician: C. Webb

Reviewed By: Daphne C. Malcom

*MDA is total in dpm/100 cm²

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP
(former BONUS REACTOR FACILITY) Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 1503 hrs Date: Yr 2018 Mo 11 Dy 28

Task: Comprehensive Survey RWP: NA

Map key: ° = Sample Location □ = Air Sampler Location _ = Core Sample

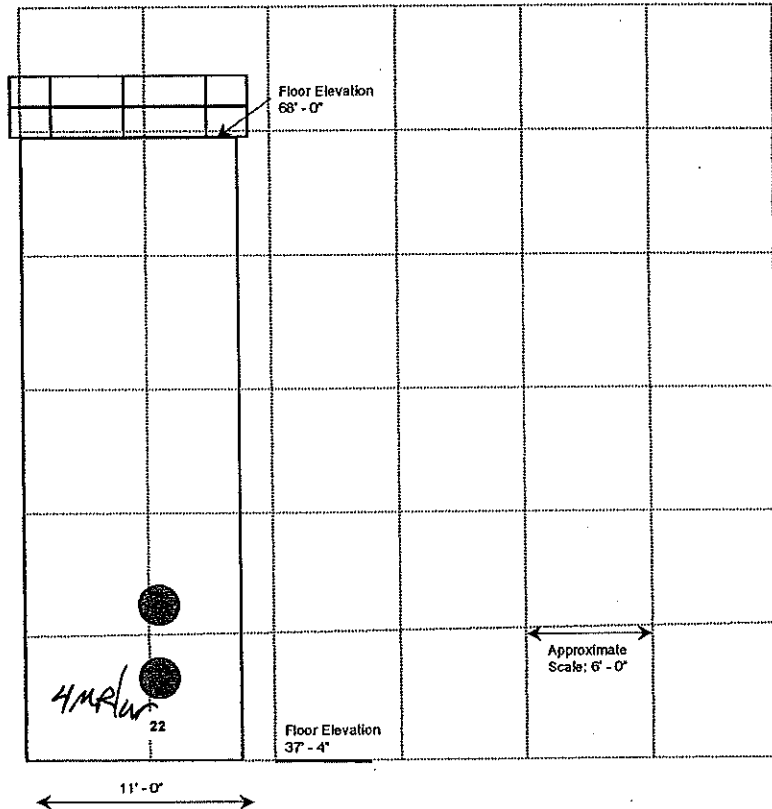
Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: South Side

Sketch:

Entombment System - South View

1 = Sample Locations



Instruments (Model and Serial Numbers): Model 19, #148190

Survey Technician(s): C. Webb

Reviewed by:
Stephen C. Henderson

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1505hrs Task Number N/A

Specific Area of Survey: Entombed Building-SouthWest Side MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts))})/E \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A= $(Sample-Bkg)/E \times CF$

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1012	40	609
<u>NA</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u> %	<u>NA</u>	<u>NA</u>	<u>NA</u>

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		β Removable	β Total	β Removable	β Total
23	SouthWest Side	<u>N/A</u>	<u>29</u>	<u>N/A</u>	<u><MDA</u>
<u>NA</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u>
<u>NA</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u>	<u>N/A</u>	<u>NA</u>

Survey Technician: C. Webb

Reviewed By: Stephen C. Malcom

*MDA is total in dpm/100 cm²

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 1508-hrs Date: Yr 2018 Mo 11 Dy 28

Task: Comprehensive Survey RWP: NA

Map key: ° = Sample Location □ = Air Sampler Location _ = Core Sample

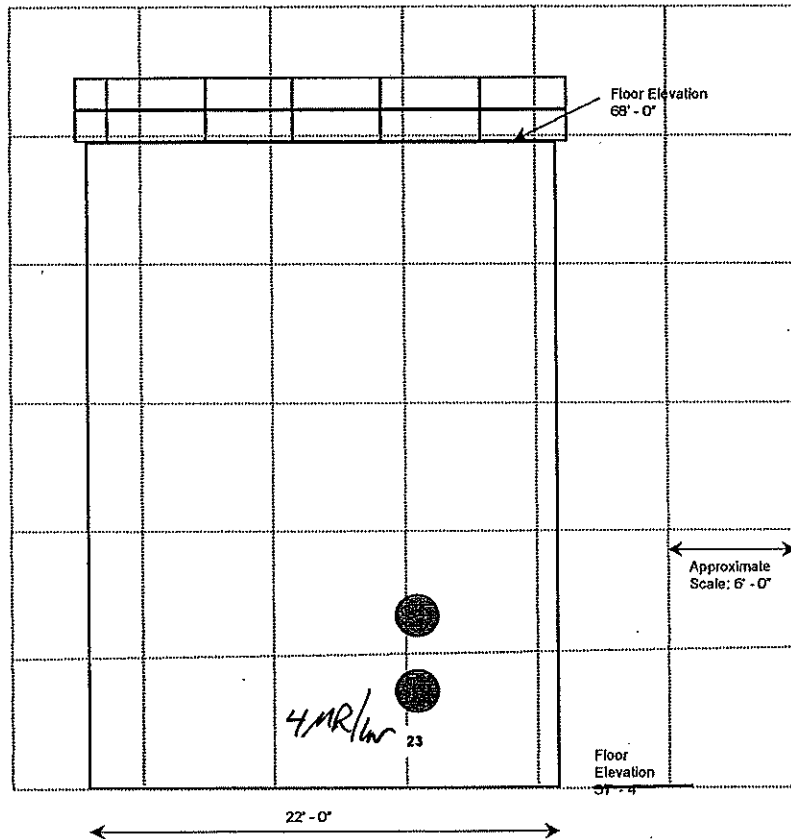
Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: SouthWest Side

Sketch:

Entombment System - Southwest View

° = Sample Locations



Instruments (Model and Serial Numbers): Model 19, #148190

Survey Technician(s): C. Webb

Reviewed by:
Stephen C. Holcomb

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1510 hrs Task Number N/A

Specific Area of Survey: Entombed Building-NoruthWest Side MDA= $(2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg+Bkg/Ts})/E \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A= $(Sample-Bkg)/E \times CF$

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1012	40	609
NA	NA	NA	NA	NA	NA	NA %	NA	NA	NA

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		βy Removable	βy Total	βy Removable	βy Total
25	NorthWest Side	N/A	43	N/A	<MDA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA

Survey Technician: C. Webb

Reviewed By: Stephen C. M... ..

*MDA is total in dpm/100 cm²

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 1513 hrs Date: Yr 2008 Mo 11 Dy 28

Task: Comprehensive Survey RWP: NA

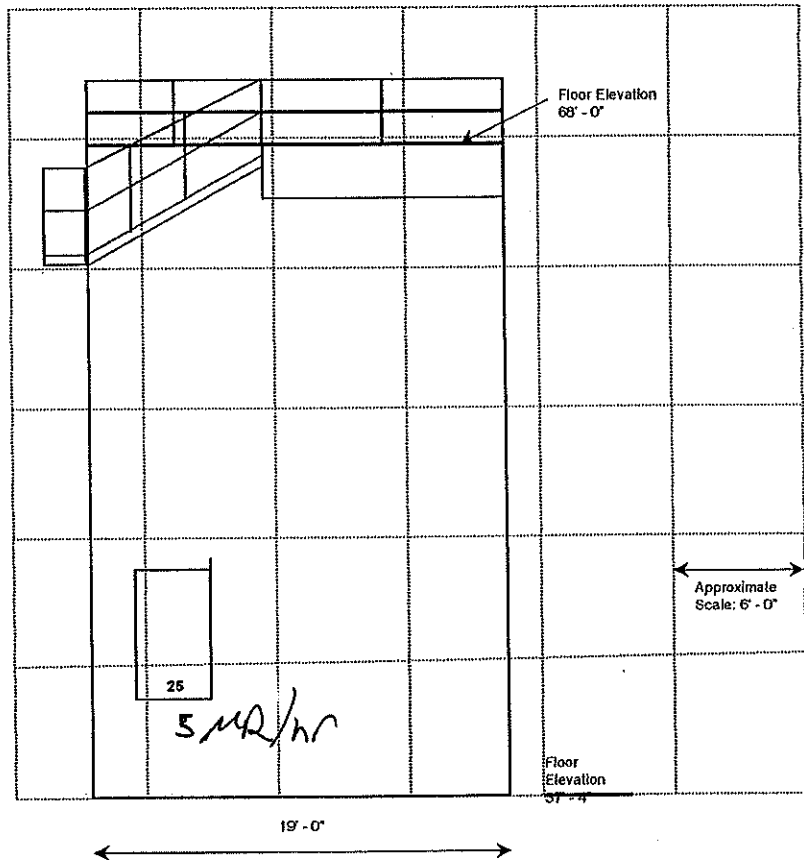
Map key: ° = Sample Location □ = Air Sampler Location ___ = Core Sample

Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: NorthWest Side

Sketch: Entombment System - Northwest View

1 = Sample Locations



Instruments (Model and Serial Numbers): Model 19, #148190

Survey Technician(s): C. Webb

Reviewed by:
Stephen G. Halemb

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1450 hrs Task Number N/A

Specific Area of Survey: Entombed Building-Main Floor $MDA = ((2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg+Bkg/Ts})/E) \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey $A = (Sample - Bkg)/E \times CF$

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm ²
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18%	1012	40	609
<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i> %	<i>NA</i>	<i>NA</i>	<i>NA</i>

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
20	Main Floor	<i>N/A</i>	<i>40</i>	<i>N/A</i>	<i><MDA</i>
21	Main Floor	<i>NA</i>	<i>65</i>	<i>N/A</i>	<i>926</i>
27	Main Floor	<i>N/A</i>	<i>376</i>	<i>N/A</i>	<i>12,451</i>
28	Main Floor	<i>N/A</i>	<i>1,600</i>	<i>N/A</i>	<i>57,807</i>
27A	Main Floor	<i>N/A</i>	<i>1,614</i>	<i>N/A</i>	<i>58 <MDA</i>
27B	Main Floor	<i>N/A</i>	<i>62</i>	<i>N/A</i>	<i>815</i>
28 Dup	Main Floor	<i>N/A</i>	<i>1,614</i>	<i>N/A</i>	<i>58,325</i>
<i>NA</i>	<i>NA</i>	<i>N/A</i>	<i>NA</i>	<i>N/A</i>	<i>NA</i>

Survey Technician: C. Webb

Reviewed By: Stephen C. Delacruz

*MDA is total in dpm/100 cm²

$MDA_{cpm} \approx 56 \text{ cpm}$

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/29/18 ; 1315 hrs Task Number N/A

Specific Area of Survey: Public Access Areas - Main Floor $MDA = ((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg + Bkg/Ts)})/E) \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey $A = (Sample - Bkg)/E \times CF$

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading CPM	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1012	70	802
NA		NA	NA	NA	NA	NA %	NA	NA	NA

SURVEY DATA		Survey Map Attached <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
65-Q	Quarterly Point 65 - Main Floor	N/A	61	N/A	<MDA
66-Q	Quarterly Point 66 - Main Floor	N/A	67	N/A	<MDA
67-Q	Quarterly Point 67 - Main Floor	N/A	72	N/A	<MDA
68-Q	Quarterly Point 68 - Main Floor	N/A	74	N/A	<MDA
69-Q	Quarterly Point 69 - Main Floor	N/A	66	N/A	<MDA
69-Q Dup	Duplicate	N/A	88	N/A	<MDA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA
NA	NA	N/A	NA	N/A	NA

Survey Technician: C. Webb
 Reviewed By: Stephen C. Holcomb

*MDA is removable/total in dpm/100 cm²

MDA ≈ 791 cpm

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 11/30/18, 0830 hrs Task Number NA
 Specific Area of Survey: Entombed Building-Main Floor $MDA = ((2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg + Bkg/Ts})/E) \times CF$
 Purpose of Survey: Year 2017-2018 Comprehensive Survey $A = (Sample - Bkg)/E \times CF$

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1011	47	N/A
NA	NA	NA	NA	NA	NA	NA%	NA	NA	NA

SURVEY DATA						Survey Map Attached <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²			
		By Removable	By Total	By Removable	By Total		
65	Main Floor-Masslin (Zone 1)	45	N/A	<MDA	N/A		
66	Main Floor-Masslin (Zone 2)	44	N/A	<MDA	N/A		
67	Main Floor-Masslin (Zone 3)	54	N/A	<MDA	N/A		
68	Main Floor-Masslin (Zone 4)	50	N/A	<MDA	N/A		
69	Main Floor-Masslin (Zone 5)	38	N/A	<MDA	N/A		
72	Main Floor-Masslin (Zone 6)	56	N/A	<MDA	N/A		
73	Main Floor-Masslin (Zone 7)	58	N/A	<MDA	N/A		
74	Main Floor-Masslin (Zone 8)	44	N/A	<MDA	N/A		
75	Main Floor-Masslin (Zone 9)	54	N/A	<MDA	N/A		
76	Main Floor-Masslin (Zone 10)	42	N/A	<MDA	N/A		
77	Main Floor-Masslin (Zone 11)	52	N/A	<MDA	N/A		
78	Main Floor-Masslin (Zone 12)	44	N/A	<MDA	N/A		
79	Main Floor-Masslin (Zone 14)	36	N/A	<MDA	N/A		
80	Main Floor-Masslin (Zone 13)	46	N/A	<MDA	N/A		

Survey Technician: C. Webb
 Reviewed By: Stephen G. Malcom

*MDA < 200 dpm/100cm² (cannot be quantified due to large area survey).

200 dpm/100cm² ≈ 83 cpm

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building Time: 0850 Date: Yr 18 Mo 11 Dy 29

Task: Comprehensive Survey RWP: NA

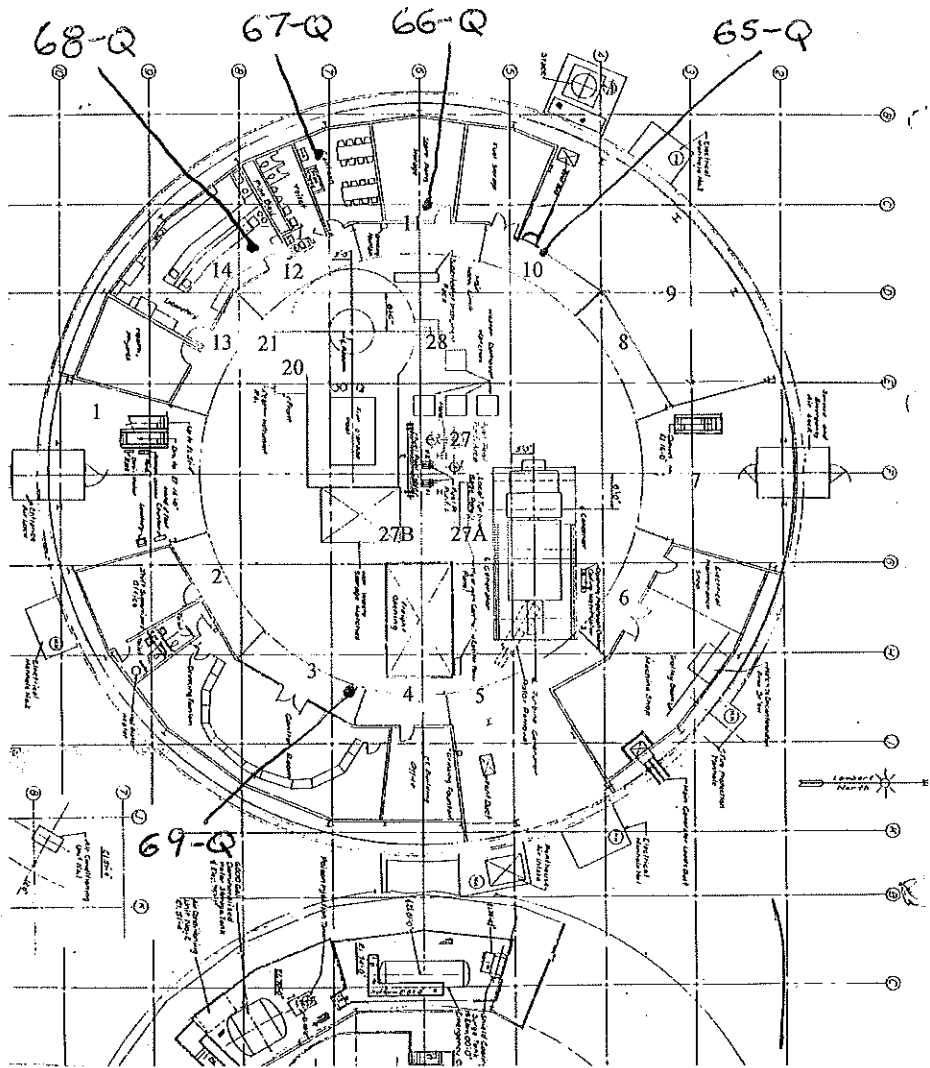
Map key: ° = Sample Location □ = Air Sampler Location _ = Core Sample

Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: Main Floor

Sketch:

No.	μR/hr
Zone 1= 65	6
Zone 2= 66	7
Zone 3= 67	5
Zone 4= 68	5
Zone 5= 69	5
Zone 6= 72	6
Zone 7= 73	5
Zone 8= 74	5
Zone 9= 75	5
Zone 10= 76	4
Zone 11= 77	6
Zone 12= 78	5
Zone 13= 80	5
Zone 14= 79	5
Zone <u>NA</u>	<u>NA</u>
Zone <u>NA</u>	<u>NA</u>
20	6
21	5
27	17
28	14
27A	4
27B	4
27 Dup	17
65-Q	5
66-Q	6
67-Q	6
68-Q	6
69-Q	5
69-Q Dup	5



Instruments (Model and Serial Numbers): Model 19, #148190

Reviewed by:
Stephen Cañabarro

Survey Technician(s): C. Webb + J. Lopez

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TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/29/18; 0900ks Task Number N/A

Specific Area of Survey: Entombed Building-Basement Floor MDA=((2.71/Tbkg + 3.3sqrt(Bkg/Tbkg+Bkg/Ts))/E x CF

Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E x CF

Table with 10 columns: Inst. Type, Serial #, Cal. due date, Probe type, Serial #, Cal. due date, Efficiency, Ct. Time Tbkg/Ts (minutes), Bkgd Reading (cpm), MDA* dpm/100cm². Row 1: Ludlum 2221, 149991, 8/2/19, 44-9, 154535, 8/2/19, 18%, 1012, 35, 570. Row 2: NA, NA, NA, NA, NA, NA, NA%, NA, NA, NA.

SURVEY DATA

Survey Map Attached Yes No

Table with 6 columns: No., Description/Location, Gross Counts in CPM (By Removable, By Total), Contamination in dpm/100 cm² (By Removable, By Total). Rows include: 30 Basement Floor-Side of Tank #1 (74, N/A), 31 Basement Floor-Side of Tank #2 (75, N/A), 40A Basement Floor-Wall (4" from floor) (165, N/A), 40B Basement Floor-Wall (4" from floor) (60, N/A), 42 Basement Floor (50, N/A), 43 Basement Floor (45, N/A), 50A Basement Floor-Wall (block) (42, N/A), 50B Basement Floor-Wall (concrete) (46, N/A), 40A Dup Basement Floor-Wall (4" from floor) (172, N/A), X 40A-1 Back of probe (146, N/A), 2018-2 Condensate Pump #2 dust (128, N/A), 2018-1 Condensate Pump #1 Base (76, N/A), 2018-3 Cond. Pump #2 dust separated (83**, 83**, 1,779**), 2018-4 Cond. Pump #2 dust at base (106, N/A), NA, NA, NA.

Survey Technician: C. Webb

Reviewed By: Stephen G. Malcom

**Dust at base of pump was placed on paper and counted directly and separate from pump. Used CF=6.67

MDAcpm ≈ 50cpm

**TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 11/30/18, 0945 hrs Task Number NA
 Specific Area of Survey: Entombed Building-Basement Floor MDA= $((2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg+Bkg/Ts}))/E \times CF$
 Purpose of Survey: Year 2017-2018 Comprehensive Survey A= $(Sample-Bkg)/E \times CF$

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1011	47	N/A
<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>NA</i> %	<i>NA</i>	<i>NA</i>	<i>NA</i>

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
70	Masslin - Zone 1	30	NA	<MDA	NA
71	Masslin - Zone 2	38	NA	<MDA	NA
81	Masslin - Zone 3	51	NA	<MDA	NA
89	Masslin - Zone 4	33	NA	<MDA	NA
90	Masslin - Zone 5	49	NA	<MDA	NA
91	Masslin - Zone 6	38	NA	<MDA	NA
92	Masslin - Zone 7	41	NA	<MDA	NA
93	Masslin - Zone 8	41	NA	<MDA	NA
94	Masslin - Zone 9	33	NA	<MDA	NA
95	Masslin - Zone 10	38	NA	<MDA	NA
96	Masslin - Zone 11	43	NA	<MDA	NA
97	Masslin - Zone 12	33	NA	<MDA	NA
98	Masslin - Zone 13	36	NA	<MDA	NA

Survey Technician: C. Webb
 Reviewed By: Stephen C. Madenlo

*MDA < 200 dpm/100 cm² (cannot be quantified due to large area survey).

$$200 \text{ dpm}/100 \text{ cm}^2 \approx 83 \text{ cpm}$$

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/30/18, 1005 hrs Task Number NA

Specific Area of Survey: Entombed Building-Basement Floor MDA= $((2.71/Tbkg + 3.3\sqrt{Bkg/Tbkg+Bkg/Ts}))/E \times CF$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E x CF

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1011	47	N/A
NA	NA	NA	NA	NA	NA	NA%	NA	NA	NA

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
99	Masslin - Zone 14	51	NA	<MDA	NA
100	Masslin - Zone 15	40	NA	<MDA	NA
101	Masslin - Zone 16	32	NA	<MDA	NA
102	Masslin - Zone 17	41	NA	<MDA	NA
103	Masslin - Zone 18	39	NA	<MDA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA

Survey Technician: C. Webb

Reviewed By: Stephen Q. Mendez

*MDA < 200 dpm/100 cm² (cannot be quantified due to large area survey).

$$\frac{200 \text{ dpm}}{100 \text{ cm}^2} \approx 83 \text{ cpm}$$

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE:

Entombed Reactor Building

Time: 1030hrs

Date: Yr 18 Mo 11 Dy 29

Task: Comprehensive Survey

RWP: NA

Building: Entombed Reactor Building

Location: Basement Floor

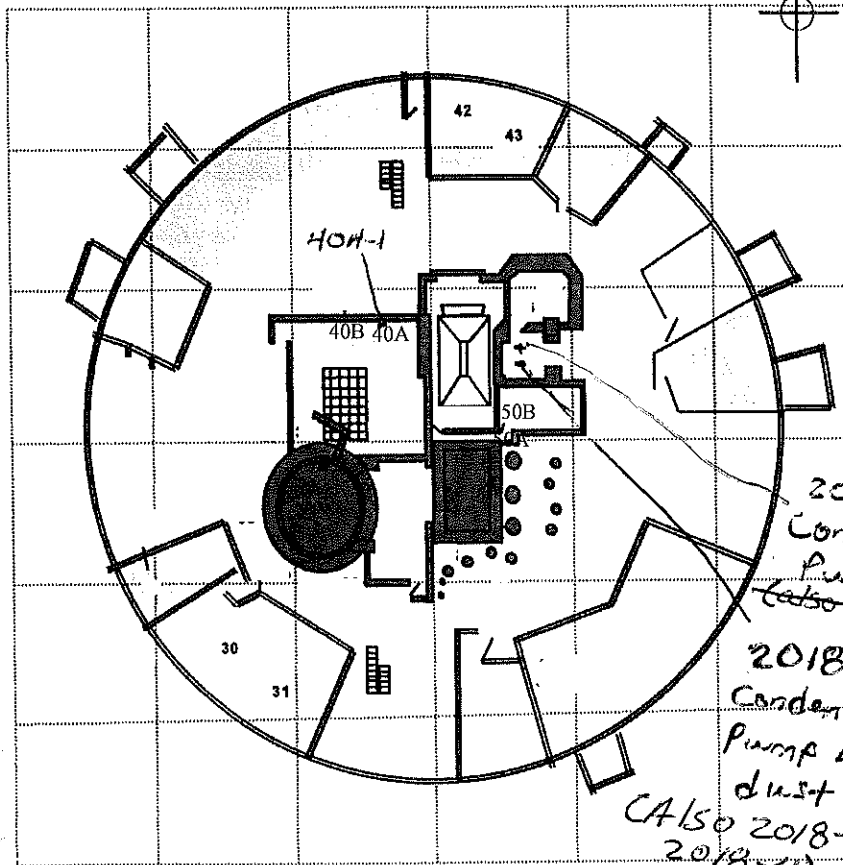
Sketch:

No. μ R/hr

1 = Sample Locations



Zone 1 = 70	6
Zone 2 = 71	6
Zone 3 = 81	6
Zone 4 = 89	6
Zone 5 = 90	4
Zone 6 = 91	5
Zone 7 = 92	5
Zone 8 = 93	5
Zone 9 = 94	5
Zone 10 = 95	5
Zone 11 = 96	5
Zone 12 = 97	5
Zone 13 = 98	6
Zone 14 = 99	6
Zone 15 = 100	5
Zone 16 = 101	5
Zone 17 = 102	5
Zone 18 = 103	5
30	15
31	13
40A	15
40A Dup	20-15
40B	11
42	5
43	4
50A	5
50B	6
2018-1	14
2018-2	14



2018-1
Condensate
Pump #1
also CW
11/29/18

2018-2
Condensate
Pump #2
dust
also 2018-3 and
2018-4)

■ = SCM Survey
Above 100 cm² limit

Instruments (Model and Serial Numbers): 19 S/N 148190

Survey Technician(s): C. Webb + J. Lopez

Reviewed by:
Stephen G. Hale

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 11/28/18; 1930hrs Task Number N/A

Specific Area of Survey: Smears MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts)})/E$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18%	1011	40	123
NA	NA	NA	NA	NA	NA	NA%	NA	NA	NA

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
1	Smear	41	N/A	<MDA	N/A
2	Smear	35	N/A	<MDA	N/A
3	Smear	47	N/A	<MDA	N/A
4	Smear	42	N/A	<MDA	N/A
4 Dup	Duplicate Count	35	N/A	<MDA	N/A
5	Smear	34	N/A	<MDA	N/A
6	Smear	42	N/A	<MDA	N/A
7	Smear	23	N/A	<MDA	N/A
8	Smear	26	N/A	<MDA	N/A
9	Smear	32	N/A	<MDA	N/A
10	Smear	22	N/A	<MDA	N/A
11	Smear	40	N/A	<MDA	N/A
12	Smear	36	N/A	<MDA	N/A
13	Smear	31	N/A	<MDA	N/A
14	Smear	37	N/A	<MDA	N/A
15	Smear	46	N/A	<MDA	N/A
16	Smear	40	N/A	<MDA	N/A

Survey Technician: C. Webb

Reviewed By: Stephen C. Maden

*MDA is removable in dpm/100 cm²

MDA_{rem} = 62cpm

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)

Rincón, Puerto Rico

CONTAMINATION SURVEY FORM

Project: BONUS - MMG Date/Time 4/28/18; 1950 hrs Task Number N/A

Specific Area of Survey: Smears MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts)})/E$

Purpose of Survey: Year 2017-2018 Comprehensive Survey A= $(Sample-Bkg)/E$

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1011	40	123
NA	NA	NA	NA	NA	NA	NA%	NA	NA	NA

SURVEY DATA

Survey Map Attached Yes No

No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
17	smear	35	N/A	<MDA	N/A
18	smear	30	N/A	<MDA	N/A
19	smear	29	N/A	<MDA	N/A
20	smear	34	N/A	<MDA	N/A
21	smear	50	N/A	<MDA	N/A
22	smear	28	N/A	<MDA	N/A
23	smear	39	N/A	<MDA	N/A
24	smear	40	N/A	<MDA	N/A
25	smear	30	N/A	<MDA	N/A
26	smear	31	N/A	<MDA	N/A
27	smear	29	N/A	<MDA	N/A
27A	smear	31	N/A	<MDA	N/A
27B	smear	32	N/A	<MDA	N/A
28	smear	32	N/A	<MDA	N/A
N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A

Survey Technician: C. Webb
 Reviewed By: Stephen G. Holcomb

*MDA is removable in dpm/100 cm²

TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 11/29/18 ; 10:55 hrs Task Number N/A
 Specific Area of Survey: Smears MDA= $((2.71/Tbkg + 3.3\sqrt{(Bkg/Tbkg+Bkg/Ts)})/E$
 Purpose of Survey: Year 2017-2018 Comprehensive Survey A=(Sample-Bkg)/E

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA*
Ludlum 2221	149991	8/2/19	44-9	154535	8/2/19	18 %	1011	47	133
NA	NA	NA	NA	NA	NA	NA%	NA	NA	NA

SURVEY DATA		Survey Map Attached <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
No.	Description/Location	Gross Counts in CPM		Contamination in dpm/100 cm ²	
		By Removable	By Total	By Removable	By Total
30	Smear	49	N/A	<MDA	N/A
31	Smear	54	N/A	<MDA	N/A
40A	Smear	35	N/A	<MDA	N/A
40B	Smear	31	N/A	<MDA	N/A
42	Smear	43	N/A	<MDA	N/A
43	Smear	31	N/A	<MDA	N/A
50A	Smear	48	N/A	<MDA	N/A
50B	Smear	39	N/A	<MDA	N/A
2018-1	Smear	48	N/A	<MDA	N/A
2018-2	Smear	41	N/A	<MDA	N/A
2018-1 Dup	Duplicate count	37	N/A	<MDA	N/A
65-Q	Smear	37	N/A	<MDA	N/A
66-Q	Smear	49	N/A	<MDA	N/A
67-Q	Smear	38	N/A	<MDA	N/A
68-Q	Smear	37	N/A	<MDA	N/A
69-Q	Smear	39	N/A	<MDA	N/A
69-Q Dup	Duplicate Count	41	N/A	<MDA	N/A

Survey Technician: C. Webb
 Reviewed By: Stephen G. Helemb

*MDA is removable in dpm/100 cm²

MDA_{cpm} ≈ > 70 cpm

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APPENDIX C
PHYSICAL CONDITION – INSPECTION CHECKLIST

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Inspection Checklist BONUS Decommissioned Facility, Rincón, Puerto Rico

Date of This Inspection/Revision:

30 November 2018

Last Inspection:

13-15 September 2016

Inspectors:

C. Webb and J. Lopez

Next Inspection (Planned):

Summer 2019

No.	Item	Issue	Action
1	Specific site surveillance features	See attached table.	Inspect. <i>See page 3 of 3</i>
2	Dome—entombed concrete monolith and monolith penetrations	Structural defects or degradation can result in loss of containment of radioactive materials.	Inspect for possible indications of structural problems, such as cracking, staining, and spalling. Notes: <i>No significant change. Minor superficial cracks.</i>
3	Dome—external piping systems	Systems were flushed during decommissioning. Incidental contamination remains, which may be released if systems corrode or otherwise fail.	Inspect for possible indications of deterioration, such as peeling and blistering paint, staining, and flaking. Notes: <i>Team could not access southern outfall due to dense vegetation. Outfall pipes on west (beach) side need to be cleared of sand and debris.</i>
4	Dome—Basement Level	Some areas contain radiological contamination in excess of DOE standards; the general public is not allowed access to contaminated areas.	Note condition of access control barricades. Notes: <i>Access control is maintained. Oil drips are contained by absorbent pads. Interior walls are spalling creating concrete debris.</i>
5	Dome—Basement Level flooding	Water accumulating in Basement Level may mobilize and redistribute surface contamination.	Inspect for gasket and storm water drains. Notes: <i>Gasket is working effectively, but continues to blister/pool in several areas due to low areas retaining water.</i>
6	Dome—Main Level	Some areas contain radiological contamination in excess of DOE standards; the general public is not allowed access to contaminated areas.	Note condition of access control barricades, ceramic floor tile, and lead blocks; note general housekeeping. Notes: <i>Controls are in good condition and maintained. No active termites on main level.</i>

*Reviewed by:
Stephen C. Holcomb*

7	Dome—Mezzanine Level	Some areas contain radiological contamination in excess of DOE standards; the general public is not allowed access to contaminated areas.	Note condition of access control to mezzanine; note general housekeeping. Notes: <i>All access gates/controls were locked and maintained. Fan motor is not working to move air through the facility.</i>
8	Dome—exterior	Building should appear well maintained	Visually inspect. Notes: <i>Dome exterior coating appears damaged on southern side due to 2017 hurricane S. See pics.</i>
9	Surrounding land	New or changing features or activities adjacent to the site may affect site security.	Note changes within 0.25 mile (400 m) of site. Notes: <i>Trails outside the fenced area are being used for mountain biking trails. There is a new mattress in an out-building (see pics).</i>
10	General site upkeep	Building should appear well maintained.	Observe and evaluate changes in site conditions. Notes: <i>The roof of admin. buildings and ancillary buildings appear in fair condition - no signs of leaks.</i>
11	Site security	Security guard should be stationed at site at all times.	Ensure security guard is present. Notes: <i>Guard present at all times.</i>
12	Erosion	Ensure that hill slopes and beach adjacent to site are not actively eroding in a way that could adversely affect the Facility.	Evaluate erosional features on adjacent slopes and beach. Notes: <i>No significant erosion on beach slopes - west (beach) side of property.</i>

Reviewed by:
Stephen G. Holcomb

**Checklist Of Site Specific Surveillance Features
BONUS Decommissioned Facility, Rincón, Puerto Rico**

Feature	Comment
Access road and parking area	Asphalt No significant changes - some broken asphalt, but functional
Entrance gate	Motor-operated Motor is not operational, but guard was always present and maintained lock/key for gate. The guard opened/closed the gate.
Access through security gate	Note security of site; sign-in required on log sheet Guard required sign-in on log sheet. Pertinent information was recorded.
Security fence	Chain-link, topped with three strands of barbed wire There is significant damage to the fence from the 2017 hurricanes. There are several locations requiring repair (approximately 100-ft)
Dome—monolith plaques	Visually inspect Plaques are in good shape.

Reviewed by:
Stephen G. Melcaud

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APPENDIX D
CALIBRATION SHEETS AND DAILY RESPONSE CHECKS

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Designer and Manufacturer
of
Scientific and Industrial
Instruments

www.ludlums.com

LUDLUM MEASUREMENTS, INC.

501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.



CERT # 4084.01

CERTIFICATE OF CALIBRATION

Customer PUERTO RICO ELECTRIC POWER AUTHORITY ORDER NO. 20337570/466823

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 148190

Mfg. _____ Model _____ Serial No. _____

Cal. Date 2-Aug-18 Cal Due Date 2-Aug-19 Cal. Interval 1 Year Meterface 202-016

Check mark applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 44 % Alt 700.0 mm Hg

New Instrument Instrument Received Within Toler. +10% 10-20% Out of Tol. Requiring Repair Other-See comments

Mechanical ck. Meter Zeroed Background Subtract Input Sens. Linearity

F/S Resp. ck. Reset ck. Window Operation Geotropism

Audio ck. Alarm Setting ck. Batt. ck.

Calibrated in accordance with LMI SOP 14.8 Calibrated in accordance with LMI SOP 14.9

Instrument Volt Set 550 V Input Sens. 31 mV Det. Oper. _____ V at _____ mV Threshold Dial Ratio _____ = _____ mV

HV Readout (2 points) Ref./Inst. _____ / _____ V Ref./Inst. _____ / _____ V

COMMENTS:

Cs-137 = 1 µCi check source SN 2009 reads = $\frac{270 \mu R/hr(500)}{(270 \mu R/hr)}$ with the source against the front of the can, lable down.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000 µR/hr	4000	4000
5000	1000 µR/hr	1000	1000
500	400 µR/hr = 71100 cpm	400	400
500	100 µR/hr	100	100
250	200 µR/hr = 36500 cpm	200	200
250	100 µR/hr	100	100
50	7110 cpm	40	40
50	1770 cpm	10	10
25	3650 cpm	20	20
25	910 cpm	5	5

*Uncertainty within ± 10% C.F. within ± 20%

50, 25 Range(s) Calibrated Electronically

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCCL Z540-1-1994 and ANSI N323-1978 ISO/IE 17025:2005(E) State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 S/N: 059 2171CP 2281CP 720 734 781 1131 1616 1696 1909 1916CP 2324/2521 5717CO 5719CO 60646 70897 73410 E552 G112 2168CP S-394 S-1054 T10081 T10082 Neutron Am-241 Be T-304 Ra-226 Y982

Alpha S/N _____ Beta S/N _____ Other _____

m 500 S/N 238275 Oscilloscope S/N _____ Multimeter S/N 70602489

Calibrator Duaine Jackson Title Calibrator Date 2-Aug-18

QC'd By [Signature] Title Final QC Date 3 Aug 18

AC Inst. Passed Dielectric (Hi-Pot) and Continuity Test Only Failed: _____



Designer and Manufacturer
of
Scientific and Industrial
Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.

501 Oak Street
325-235-5494

Sweetwater, TX 79556, U.S.A.



CERT # 4084.01

Customer PUERTO RICO ELECTRIC POWER AUTHORITY ORDER NO. 20337570/466823

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 149991

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR154511

Cal. Date 2-Aug-18 Cal Due Date 2-Aug-19 Cal. Interval 1 Year Meterface 202-159

Check mark applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 44 % Alt 700.0 mm Hg

New Instrument Instrument Received Within Toler. +10% 10-20% Out of Tol. Requiring Repair Other-See comments

Mechanical ck. Meter Zeroed Background Subtract Input Sens. Linearity

F/S Resp. ck. Reset ck. Window Operation Geotropism

Audio ck. Alarm Setting ck. Batt. ck.

Calibrated in accordance with LMI SOP 14.8 Calibrated in accordance with LMI SOP 14.9

Instrument Volt Set 900 V Input Sens. 50 mV Det. Oper. 900 V at 50 mV Threshold Dial Ratio 100 = 10 mV

HV Readout (2 points) Ref./Inst. 500 / 1 495 V Ref./Inst. 2000 / 1 1996 V

COMMENTS:

Cs-137 #2009 reading ~ 3,614cpm against the screen. Both 1/4 from surface.

Sr90Y90: 3432-09 21,017cpm with the source placed against protective screen of 44-9 detector.

	1/4" surface readings
Sr90Y90:sn 5281-04,act. 85,011dpm background 55cpm, source count. 22,482cpm, Eff 26%	41% 35,162 cpm
Co60:sn 0886,act. 3,416dpm background 55cpm, source count. 453cpm, Eff 13%	23% 819 cpm
Ni63:sn 99Ni220,act. 268,065dpm background 55cpm, source count. 317cpm, Eff 0.12%	0.53% 1,426 cpm
Cs-137(gamma):sn 0754,act. 148,609dpm background 55cpm, source count. 277cpm, Eff 0.18	0.2% 348 cpm
Cs-137(beta):sn 1075 ,act. 16,127dpm background 55cpm, source count. 3,755cpm, Eff 23%	30% 4,967 cpm

Firmware:26-10-10

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1000	400 Kcpm	400	400
X 1000	100 Kcpm	100	100
X 100	40 Kcpm	40	40
X 100	10 Kcpm	10	10
X 10	4 Kcpm	4	4
X 10	1 Kcpm	1	1
X 1	400 cpm	400	400
X 1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20%

ALL Range(s) Calibrated Electronically

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400 K cpm	40015	40015	500 K cpm	495	495
40 K cpm	4001	4001	50 K cpm	50	50
4 K cpm	400	400	5 K cpm	5	5
400 cpm	40	40	500 cpm	500	500
40 cpm	4	4	50 cpm	50	50

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other international Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSS Z540-1-1994 and ANSI N323-1978 ISO/IE 17025:2005(E) State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 S/N: 059 2171CP 2261CP 720 734 781 1131 1616 1696 1909 1916CP 2324/2521 5717CO 5719CO 60646 70897 73410 E552 G112 2168CP S-394 S-1054 T10081 T10082 Neutron Am-241 Be T-304 Ra-226 Y862

Alpha S/N Beta S/N Other

m 500 S/N 238276 Oscilloscope S/N Multimeter S/N 70602489

Calibrator Duaine Jackson Title Calibrator Date 2-Aug-18

QC'd By [Signature] Title Final QC Date 3 Aug 18

AC Inst. Only	<input type="checkbox"/> Passed Dielectric (Hi-Pot) and Continuity Test
	<input type="checkbox"/> Failed:

