Memorandum

Date: 21 September 2011

To: Madeline Ramos, Puerto Rico Electric Power Authority (PREPA)

Copy: Boiling Nuclear Superheat (BONUS) File and Gunseli Shareef, URS (Program Manager)

From: Chad Webb, BONUS RADCON Manager (RCM)

Subject: **2011 Annual Survey**

MMG conducted the comprehensive annual survey at the Dr. Modesto Iriarte Technological Museum (former BONUS Facility) during the dates of 4 – 5 August 2011 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.

PURPOSE

Date: 4 – 5 August 2011
Purpose: Conduct 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.

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

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	4	<MDA	<MDA	Monolith Top
Pipe Chase Face	2	4	<MDA	<MDA	Monolith Top
Pipe Chase Face	3	4	<MDA	<MDA	Monolith Top
Pipe Chase Face	4	4	<MDA	<MDA	Monolith Top
Top Plug Face #1	5	4 Dup=4	<MDA Dup=<MDA	<MDA	Monolith Top
Top Plug Face #1	6	4	<MDA	<MDA	Monolith Top
Top Plug Face #1	7	4	<MDA	<MDA	Monolith Top
Top Plug Face #2	8	5	<MDA	<MDA	Monolith Top
Top Plug Face #2	9	6	1,584	<MDA	Monolith Top
Top Plug Face #2	10	6	1,084	<MDA	Monolith Top
Top Plug Face #3	11	6	<MDA	<MDA	Monolith Top
Top Plug Face #3	12	5	<MDA	<MDA	Monolith Top
Top Plug Face #3	13	5	<MDA	<MDA	Monolith Top
Top Plug Face #4	14	4	<MDA	<MDA	Monolith Top
Top Plug Face #4	15	4	<MDA	<MDA	Monolith Top
Top Plug Face #4	16	4	<MDA	<MDA Dup=<MDA	Monolith Top
Top Plug Top Surface	17	3	<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	9	<MDA	<MDA	Main Level-Controlled Area
Main Floor Water Column	21	10	1,417	<MDA	Main Level-Controlled Area
Instrument Thimble #1	22	9	<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #2	23	7	<MDA Dup=<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #3	24	5	<MDA	<MDA	Main Level-Controlled Area
Pipe Chase Ext Hatch	25	6	<MDA	<MDA	Main Level-Controlled Area
Instrument Thimble #4	26	5	<MDA	<MDA	Main Level-Controlled Area
Fuel Pool Purif. Floor, area	27	32	18,759	<MDA	Main Level-Controlled Area
Fuel Pool Purif. Floor, area	27A	10	1,617	<MDA	Main Level-Controlled Area. Taken to define elevated area associated with 27 and 28.
Fuel Pool Purif Floor, area	27B	10	1,099	<MDA	Main Level-Controlled Area. Taken to define elevated area associated with 27 and 28.
Fuel Pool Purif. Floor (CM005)	28	30 Dup=30	88,503 Dup=83,583	<MDA Dup=<MDA	Main Level-Controlled Area

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)					
Side of Liq. Waste Ret. Tank #1	30	18	1,292	<MDA	Basement Level, Att. A – Fig.s 4 and 6
Side of Liq. Waste Ret. Tank #2	31	16	1,501	<MDA	Basement Level, Att. A – Fig.s 4, 5, and 6
F.W. Heater Room (Wall)	40A	30 Dup=30	6,295 Dup=5,628	<MDA Dup=<MDA	Basement Level, Att. A – Fig. 9
F.W. Heater Room (Wall)	40B	22	<MDA	<MDA	Basement Level, Att. A – Fig. 9
Vapor Sphere Room	42	4	<MDA	<MDA	Basement Level
Vapor Sphere Room	43	5	<MDA	<MDA	Basement Level
Condenser Room Entry Wall (Block)	50A	10	<MDA	<MDA	Basement Level, Att. A – Fig. 11
Condenser Room Entry Wall (Concrete)	50B	10	<MDA	<MDA	Basement Level, Att. A – Fig. 11
Additional Sampling Locations					
Main Floor-Zone 1	65	3	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 2	66	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 3	67	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 4	68	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 5	69	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 6	72	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 7	73	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 8	74	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 9	75	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 10	76	5	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 11	77	5	NA	<1000dpm/100cm^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	4	NA	<1000dpm/100cm^2	Main Level-Public Access. Masslin Smear
Main Floor-Zone 14	79	5 Dup=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	4	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 2	71	5	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 3	81	7	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 4	89	5	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 5	90	3	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	6	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 10	95	4	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 11	96	4	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 12	97	4	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 13	98	5	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 14	99	5	NA	<1000dpm/100cm^2	Basement Level Masslin Smear
Basement Floor-Zone 15	100	4	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 Dup=5	NA	<1000dpm/100cm^2	Basement Level Masslin Smear

dpm/100 cm^2 = disintegrations per minute per 100 centimeters squared
Dup = Duplicate
MDA = Minimum Detectable Activity
µR/hour = micro-Roentgen per hour

PHYSICAL CONDITION

Attachment 3 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 is in fair and usable condition (Attachment 1, Figures 19 through 22). The motor of the entrance gate was not operational at the time of the survey, but was manually operated by the attending guard (Attachment 1, Figures 19 and 20). The security guard controlled access into the gated facility and kept log of visitors. The Dome monolith plaques were in fair condition. At one location on the beach-side of the property, the fence needs to be prepared to control access. Repair or replacement of the gate motor is recommended, but not critical in maintaining site security (repeat from 2010).

Dome-Entombed Concrete Monolith and Monolith Penetrations: Inspection of the Concrete Monolith area revealed superficial cracks throughout the surface of the structure (Attachment 1, Figure 1). Superficial cracks are also present along the base of the "top plug" of the concrete monolith top (Attachment 1, Figures 2 and 3). All dose rate measurements taken around the structure were not significantly different from background measurements taken. No immediate action is necessary.

Dome-External Piping Systems: Inspection of accessible external piping systems revealed no significant indications of deterioration. Some areas of flaking paint were noted. No immediate action is necessary.

Dome-Basement Level: Corrosion is 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 where surface contamination was present, which is preventing contact with previously accessible contaminated and corroding surfaces. Only surface fissures/cracks were noted in the concrete floor covering (Attachment 1, Figure 8). Control measures (fixed with paint and concrete layer in some places), which were previously implemented, were inspected and do not require maintenance at this time (Attachment 1, Figures 9, 11, and 24). Ongoing and routine assessment of accessible surfaces in the basement is recommended to evaluate the continued effectiveness of the new flooring and control measures (e.g., paint) emplaced on previous contamination areas. Access to areas with historical removable contamination is being effectively controlled. No immediate 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 the sump is filling with silt/mud (Attachment 1, Figure 25). Sampling and removal of silt/mud should be planned within the next two to three years (repeat from 2010).

Rainwater infiltration into the Basement Level is occurring due to two sources:

- The rubber gasket around the exterior base of the Dome is deteriorated (Attachment 1, Figures 28 and 30). The infiltration into the Basement Level due to the deteriorated gasket is most evident by staining on the interior Basement Level walls (Attachment 1, Figures 26 and 27) near and within the Vapor Sphere Room, which is beneath the northern entrance.
- The metal frame of the Basement Level loading door is corroded and allowing rainfall to infiltrate. The paved and concrete entrance pathway outside the loading

door diverts rainwater toward the door, which infiltrates the basement through the deteriorated metal frame under the door (Attachment 1, Figures 31 and 32).

It is recommended that the exterior rubber gasket surrounding the Dome structure be replaced or repaired (repeat from 2010). Also, it is recommended that the concrete berm be expanded into a concrete ramp covering the corroded frame at the Basement Level loading entrance door after a civil survey has determined that the height of the ramp will effectively divert rainfall away from the door (repeat from 2010).

Minimal evidence of termites (vertical "tracks" on interior wall) was also noted in the Basement Level (Attachment 1, Figure 33). Since there are little to no wood building materials associated with the facility, no action is required at this time.

Dome-Main Level: The Main Level (Controlled Area) is that portion of the Main Level that is not accessible to the public (Attachment 1, Figure 4). 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 (Attachment 1, Figure 18), which is effective in reducing elevated dose rate levels in this area. Ongoing and routine assessment of the floor tile and lead bricks in this area is recommended. There is also no discernable evidence of work and/or damage affecting the control measures (floor tiles) on the Main Level, Museum Area (Attachment 1, Figures 4, 12, and 14 through 17). No immediate action is necessary on the Main Level.

Dome-Mezzanine Level: Access to ladders and stairways leading to the mezzanine level are being effectively maintained. The structure appears sound and in good condition. No immediate action is necessary.

Dome-Exterior: Inspection of the Dome structure (Attachment 1, Figure 21) did not reveal any significant structural discrepancies, although the paint on the Dome shell has faded and is flaking in spots. Also, refer to the Basement Level flooding issues mentioned above. The metallic pass-through portal at the northern entrance also shows signs of significant corrosion (Attachment 1, Figure 29) and flaking paint. It is recommended that corrosion control coating and new paint be applied to the north entrance pass-through portal to prevent any structural or mechanical damage to the entrance door mechanism (repeat from 2010).

Surrounding Land: Inspection the surrounding land within approximately 0.25 miles of the site revealed no significant changing features or activities that might affect site security. The beach immediately adjacent to the site continues to be a popular surfing location. The adjacent lighthouse and surrounding scenic overlook has reopened. No immediate action is necessary.

General Site Upkeep: The buildings and grounds appear well maintained (Attachment 1, Figure 22). However, it appears that the grass is not being routinely mowed. No immediate action is necessary.

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 (Attachment 1, Figure 23). No immediate action is necessary.

DIRECT RADIATION MONITORING

Table 1 presents direct radiation monitoring results for this survey. Attachment 2 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

Location	Dose Rate at 30 cm from Source (µR/hour)			Expected Exposure Rate[a]		Annual Dose Limits (rem/year)	
	Min. (µR/hour)	Ave. (µR/hour)	Max. (µR/hour)	Max. Exposure (hour/year)	Rate (rem/year)	Rad Worker	Visitor
Monolith Top	3	4.4	6	416	0.002	2	NA
Main Level (Controlled Area)	5	12.1	32	416	0.013	2	NA
Main Level (Public Access)	3	4.8	5	2,080 (employee)	0.010	2	NA
				832 (visitor)	0.004	NA	0.1
Basement Level	3	7.7	30	416	0.003	2	NA

rem = roentgen equivalent in man

[a]Based conservatively on the maximum-recorded dose rate at a conservative exposure scenario. For example, exposure level for the Monolith top would be 6 µR/hour × (1 rem/1,000,000 µR) × (8 hours/1 week) × (52 weeks/1 year) = 0.002 rem/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 µR/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. Attachment 4 provides a copy of instrument calibration sheets. 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.

Table 3

Location	Result (µR/hour)		RPD (%)	Comments
	Initial	Duplicate		
5	4	4	0	Very good
28	30	30	0	Very good
40A	30	30	0	Very good
79	5	5	0	Very good
103	5	5	0	Very good

RPD = Relative Percent Difference = [(Sample – Duplicate)/((Sample + Duplicate)/2)] × 100

CONTAMINATION LEVEL MONITORING

Table 1 presents contamination level monitoring results for this survey. Attachment 2 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. Two survey locations exhibited total surface contamination levels above the MDA ranging from 1,084 to 1,584 dpm/100 cm^2. These values are well below the survey action level for total surface beta/gamma contamination (5,000 dpm/100 cm^2). It is recommended that the Concrete Monolith Top be designated as a Controlled Area due to the presence of slightly elevated fixed surface beta/gamma contamination levels. 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 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, two planned survey locations, 27 and 28, had total surface beta/gamma contamination levels above the 5,000 dpm/100 cm^2 action level (18,759 and 88,503 dpm/100 cm^2, respectively). Three additional survey locations, 21, 27A and 27B (1,417, 1,617 and 1,099 dpm/100 cm^2, respectively), exhibited total surface beta/gamma contamination levels above MDA, but below the 5,000 dpm/100 cm^2 action level (27A and 27B were added to the sampling locations in 2001 and assessed to determine the extent of the surface contamination – refer to survey sketch in Attachment 2). 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. Masslin smear samples exhibited no removable contamination above MDA or 1,000 dpm/100 cm^2. 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 (Attachment 1, Figure 4). 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 cm^2. 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 (survey locations 30, 31,40A, 40B, 50A, and 50B). Attachment 1, Figures 5 through 7, 9 and 11 depict these six Basement Level survey locations. None of the smear samples from these locations exhibited removable contamination above MDA. However, one of these survey locations, 40A (Attachment 1, Figure 9), had total surface beta/gamma contamination levels above the 5,000 dpm/100 cm^2 action level (6,295 dpm/100 cm^2). Two additional survey locations, 30 and 31, exhibited a total surface contamination level above MDA, but well below the 5,000 dpm/100 cm^2 action level. Based on these results, there are no radioactive Contamination Areas associated with the Basement Level.

Two additional survey locations (42 and 43) were evaluated in the Vapor Sphere Room where a tank (Attachment 1, Figure 10) 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.

Recommendations for access control and posting of this area 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 (examples found in Attachment 1, Figures 5 through 7 and 9), 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.

Contamination Survey QA/QC

Instrument calibration records and daily response check records are maintained at the BONUS facility. Attachment 4 provides a copy of instrument calibration records. Duplicate field measurements were also made at a rate of 5% and are summarized in Table 4.

Table 4

Location	Result (dpm/100 cm^2)		RPD (%)	Comments
	Initial	Duplicate		
5 (Total Surface)	<MDA	<MDA	NA	Good
16 (Removable)	<MDA	<MDA	NA	Good
23 (Total Surface)	<MDA	<MDA	NA	Good
28 (Total Surface & Removable)	88,503 <MDA	83,583 <MDA	6% NA	Good Good
40A (Total Surface & Removable)	6,295 <MDA	5,628 <MDA	11% NA	Good Good

RPD =[(Sample – Duplicate)/[(Sample + Duplicate)/2)]] × 100

Contamination survey QA/QC checks are acceptable.

LABORATORY DATA

None.

SUMMARY OF RECOMMENDATIONS

Based on previous surveys and the 2011 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:
    - Fence repair is needed at one location on the beach-side of the property.
    - The motor of the entrance gate was not operational at the time of the survey (same as last year), but was manually operated by the attending guard. Repair or replacement of the gate motor is recommended, but not critical in maintaining site security.
    - Storm water drains appear to be functioning properly in the Basement Level, but the sump is filling with silt/mud (Attachment 1, Figure 25). Sampling and removal of silt/mud should be planned within the next two to three years (repeat from 2010).
    - The rubber gasket around exterior base of the Dome is deteriorated (Attachment 1, Figures 28 and 30). It is recommended that the exterior rubber gasket surrounding the Dome structure be replaced or repaired (repeat from 2010).
    - The metal frame of the Basement Level loading door is corroded and allowing rainfall, which is diverted toward a concrete berm at the door entrance, to infiltrate (Attachment 1, Figure 31). It is recommended that the concrete berm be expanded into a concrete ramp covering the corroded frame at the Basement Level loading entrance door after a civil survey has determined that the height of the ramp will effectively divert rainfall away from the door (repeat from 2010).
    - The metallic pass-through portal at the northern entrance shows signs of significant corrosion (Attachment 1, Figure 29) and flaking paint. It is recommended that corrosion control coating and new paint be applied to the north entrance pass-through portal to prevent any structural or mechanical damage to the entrance door mechanism (repeat from 2010).
- Concrete Monolith: It is recommended that the Concrete Monolith Top remain designated as a controlled area due to the presence of elevated fixed surface beta/gamma contamination levels. 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 exposure rates 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 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.
- Per SOP PBR-11.1.4, routine surveys are required to ensure removable contamination remains below action levels. For this purpose, 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).

Attachment 1
Photos

Figure 1. Entombment Top (North Side) – Surface Cracks (Typical)

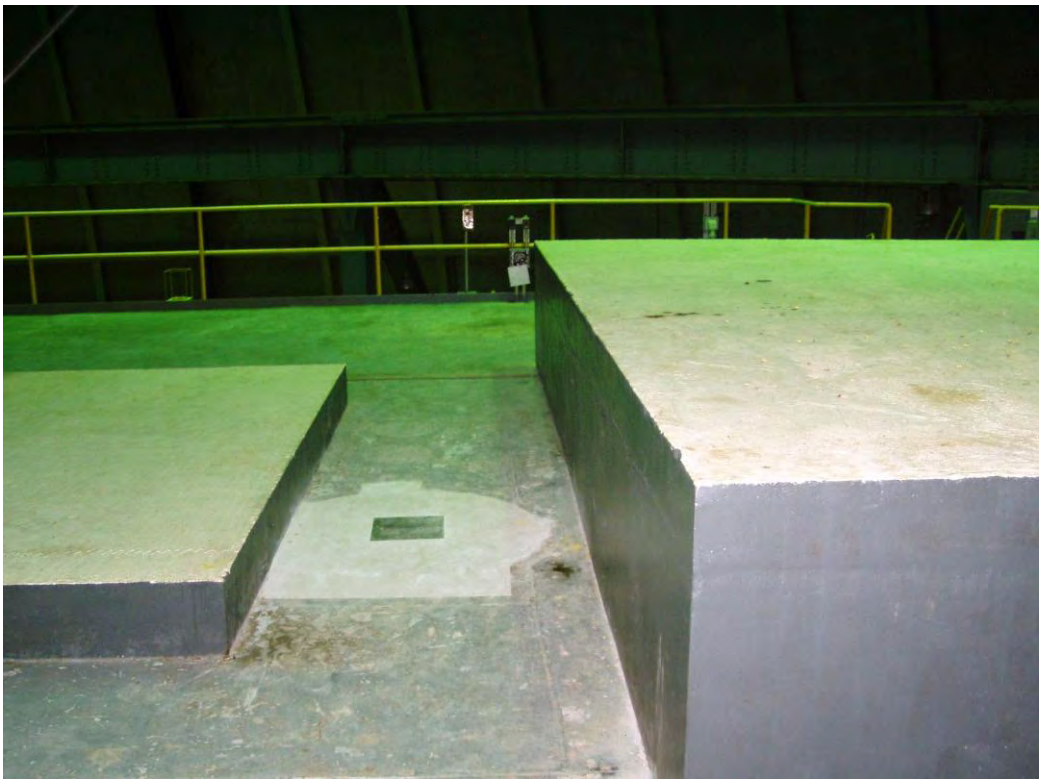


Figure 2. Entombment Top (Top Plug)

Figure 3. Entombment Top (Top Plug) – Surface Cracks (Typical)

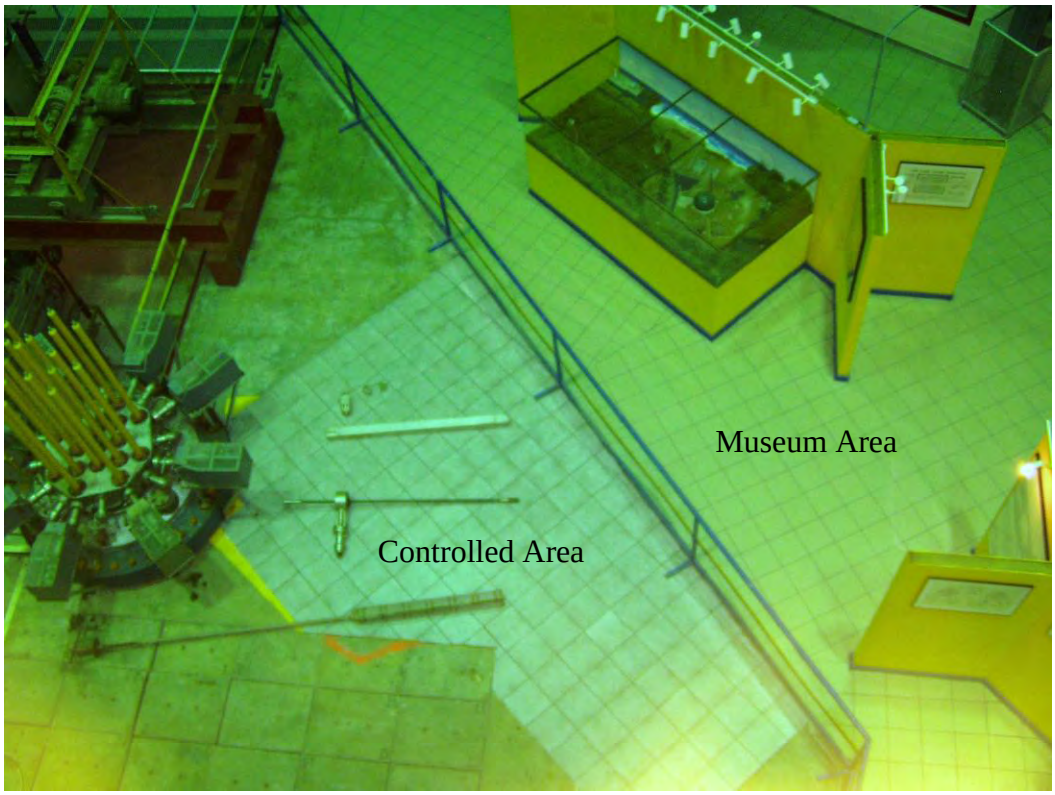


Figure 4. Main Level View from Entombment Top

Figure 5. Basement Level – Retention Tanks 1 and 2

Figure 6. Basement Level – Retention Tanks 2 and 3

Figure 7a and 7b. Basement Level – Survey Locations 30 and 31 on Retention Tanks 1 and 2, Respectively

Figure 8a and 8b. Basement Level – Surface Cracks in Concrete Cover (Typical)

Figure 9. Basement Level – Survey Locations 40A and 40B

Figure 10. Basement Level – Tank Formerly Labeled as Radioactive Material/Waste Storage Tank

Figures 11a and 11b. Basement Level – Survey Locations 50A and 50B

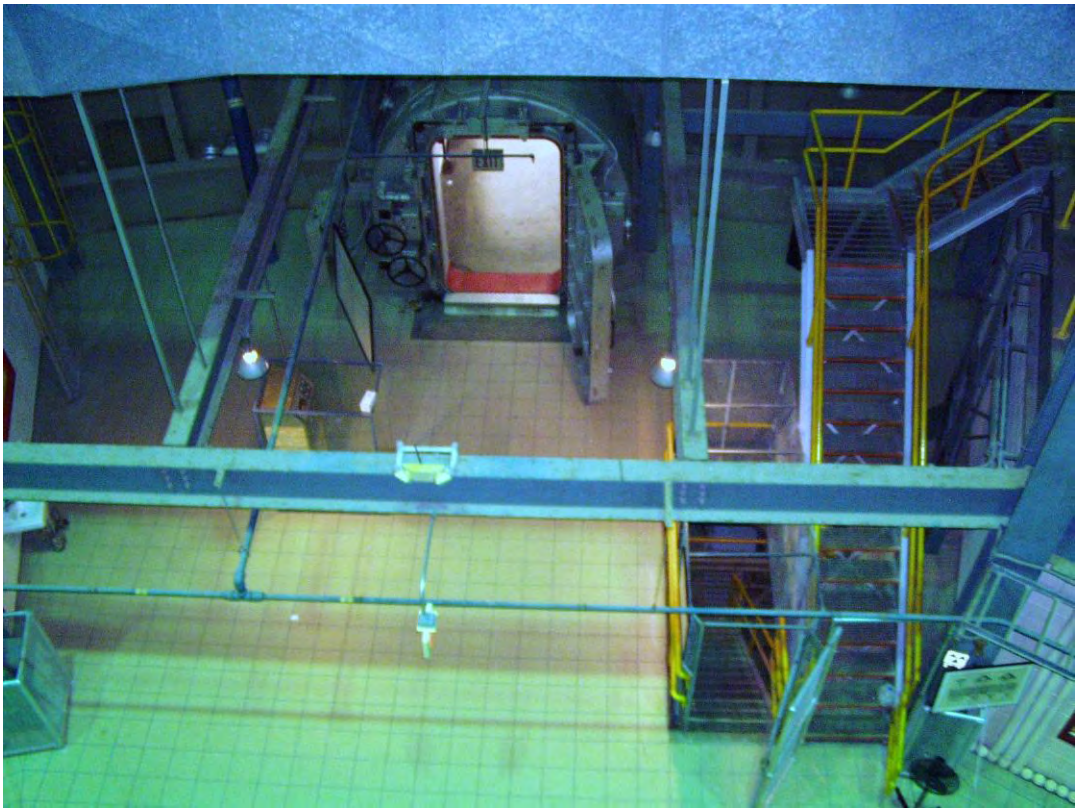


Figure 12. View from Crane Catwalk – South Side/Entrance, Main Level

Figure 13. Interior View of Dome "Shell" and Crane Catwalk

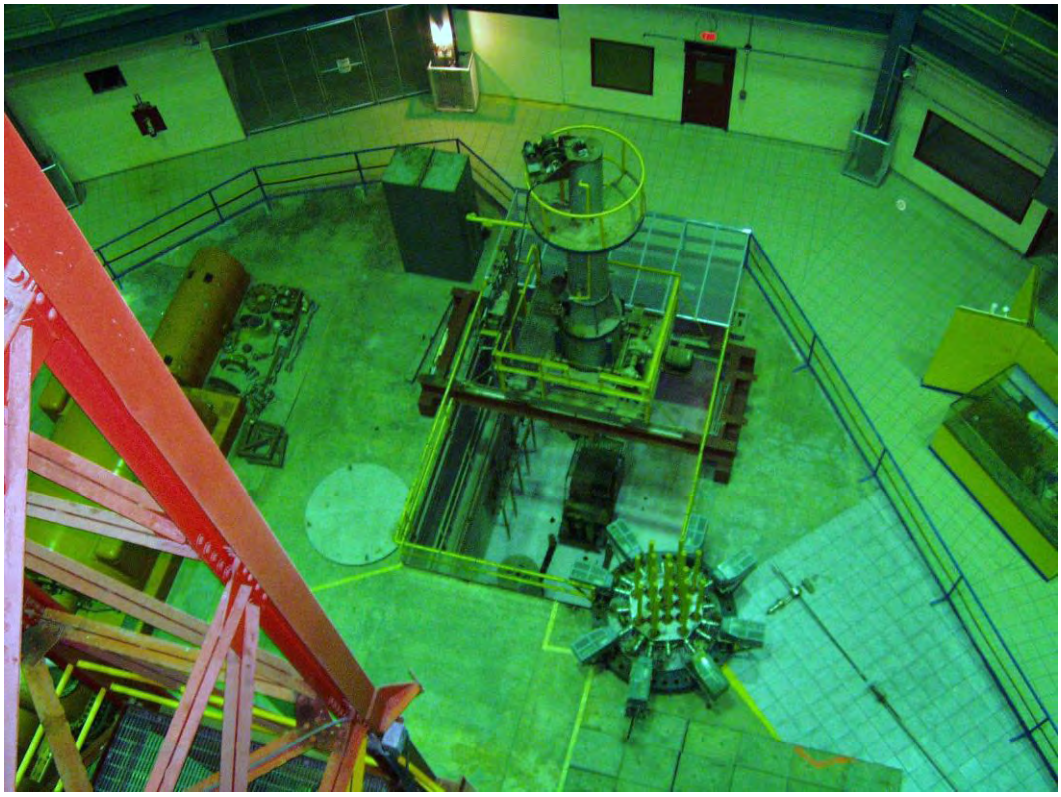


Figure 14. View from Crane Catwalk – East Side, Main Level

Figure 15. View from Crane Catwalk – North Side/Entrance, Main Level

Figure 16. View from Crane Catwalk – North/Northwest Side, Main Level

Figure 17. View from Catwalk – West/Northwest Side, Main Level (Survey Technician on Entombment Top Below)

Figures 18a and 18b. Main Level – Tile, Concrete, and Lead Bricks Covering "Hot Spot" on North Side (Adjacent to Sample Locations 27 and 28)

Figure 19. Site Security – Main Gate (Motor is Not Operational)

Figure 20. Site Security – Gate Security Building and Main Gate (Motor is Not Operational)

Figure 21. Dome Exterior

Figure 22. Support Facilities (Theatre Building on Left)

Figure 23. General Site – View from Back Deck of Theatre Building (Vegetation on Slope)

Figure 24. Basement Level – Concrete Filled Sink to Fix Removable Contamination (Good Condition)

Figure 25. Basement Level – Lowest Point in Basement Shows No Recent Signs of Flooding (Dry, Cracked Silt/Mud is Visible)

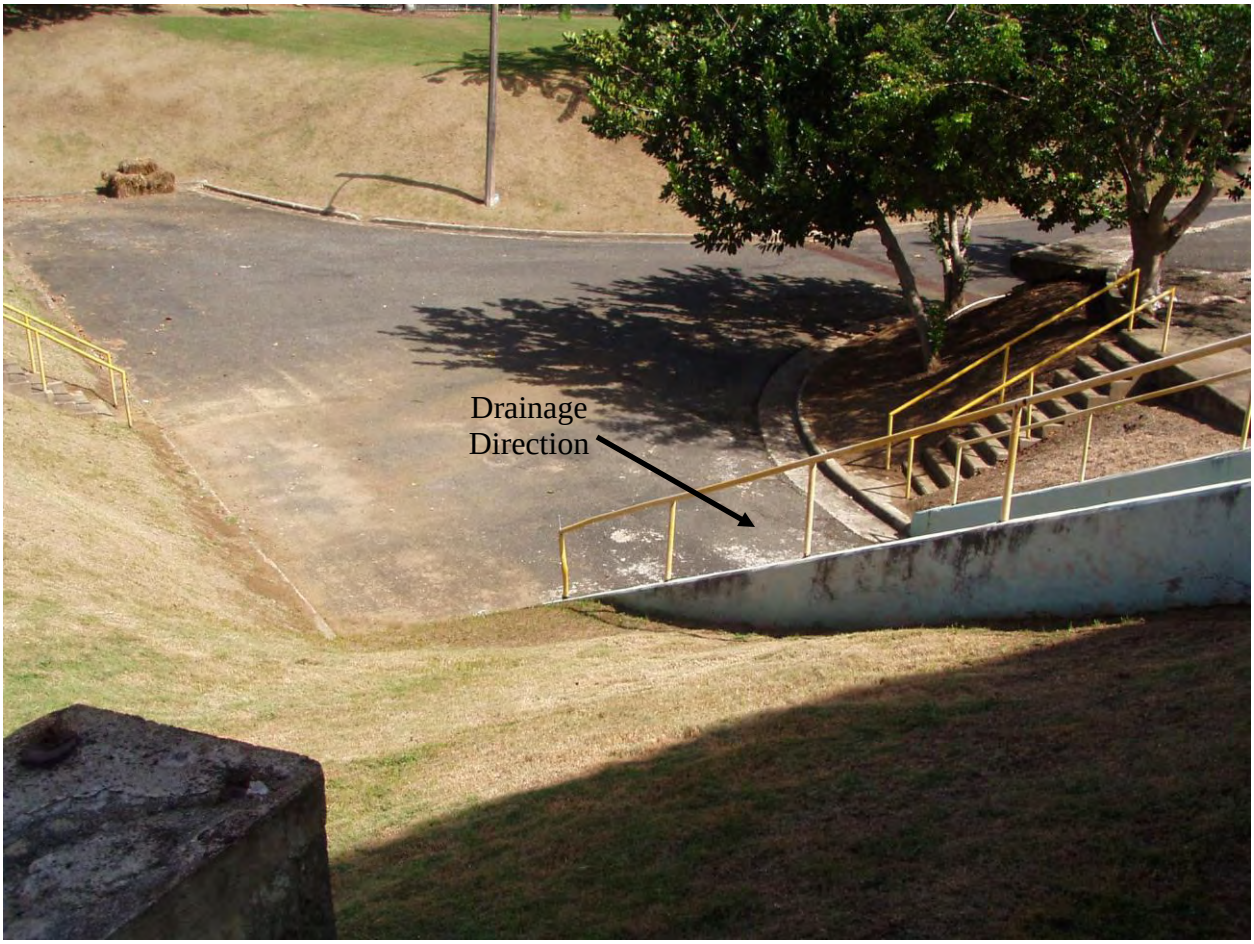
Figure 26a and 26b. Basement Level – Staining Due to Water Infiltration beneath Northern Entrance

Figure 27. Basement Level – Additional View of Staining Due to Water Infiltration beneath the Northern Entrance

Figure 28. Gasket Seal at Northern Entrance Exterior Deteriorated

Figure 29. North Entrance – Pass-Through Chamber (Significant Corrosion)

Figure 30a and 30b. Gasket Seal around Domed Metal Structure and Dome Base is Damaged and Diverts Rainwater into the Basement Level



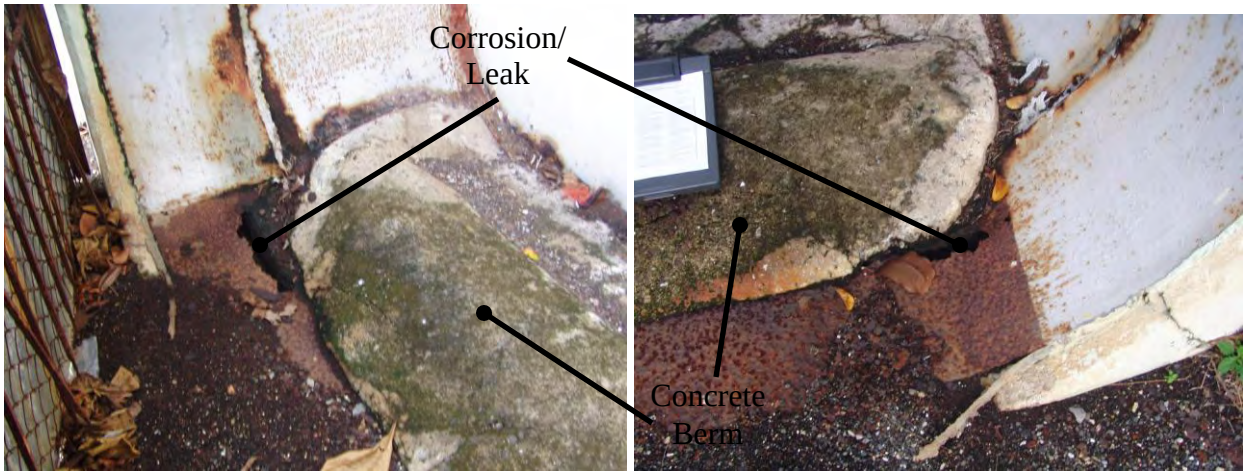


Figure 31a, 31b, and 31c. Basement Level – East Side Basement Loading Access. 31a (Top) Shows the Pave Access Pad Drains Rainwater Toward the Loading Door. 31b and 31c (Left and Right) Show a Concrete Berm Across the Loading Door to Prevent Rainwater from being Diverted into the Basement Level. However, Corrosion of the Metal Frame in Front of the Berm Allows Rainwater to Leak into the Basement.

Figure 32. Basement Level – East Side Loading Access (Interior) with Water Stain Visible on Floor (Inflow through Corrosion of Metal Frame – Figure 31.

Figure 33. Basement Level – East Side Near Loading Access (Interior) with "Termite Tracks" Visible on Wall.

Attachment 2
Annual Survey Contamination Survey Forms and Sketches

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1000 Task Number NA

Specific Area of Survey: Entombed Building-North Side MDA=((2.71/Tbkg + 3.3sqrt(Bkg/Tbkg+Bkg/Ts))/E x CF 5000

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991		44-9	154535		16 %	5 / 2	61	921
24+26		/ /	"	"	/ /	16 %	5 / 2	43	777

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
1	North Side		78		<MDA
2	North Side	see	65		<MDA
3	North Side	Smear	72		<MDA
4	North Side	Data	73		<MDA
24	North Side		40		<MDA
26	North Side		42		<MDA

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is total in dpm/100 cm²

100 Cm2
÷ 15 cm2
CF = 6.67

$$MDA = \left(\frac{\frac{2.71}{5} + 3.3\sqrt{\frac{61}{5} + \frac{61}{2}}}{.16}\right) \cdot 6.67$$

$$= 921 \ \frac{dpm}{100 cm^2}$$

$$\left(\frac{\frac{2.71}{5} + 3.3\sqrt{\frac{43}{5} + \frac{43}{2}}}{.16}\right) 6.67$$

MDA = 777 dpm/100cm²

$$921 = \frac{(S - 61)}{.16} \times 6.67$$

S = 83 cpm (MDA)

62 cpm

$$777 = \frac{(S - 43) \times 6.67}{0.16}$$

≈ 61.6

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

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 1000	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

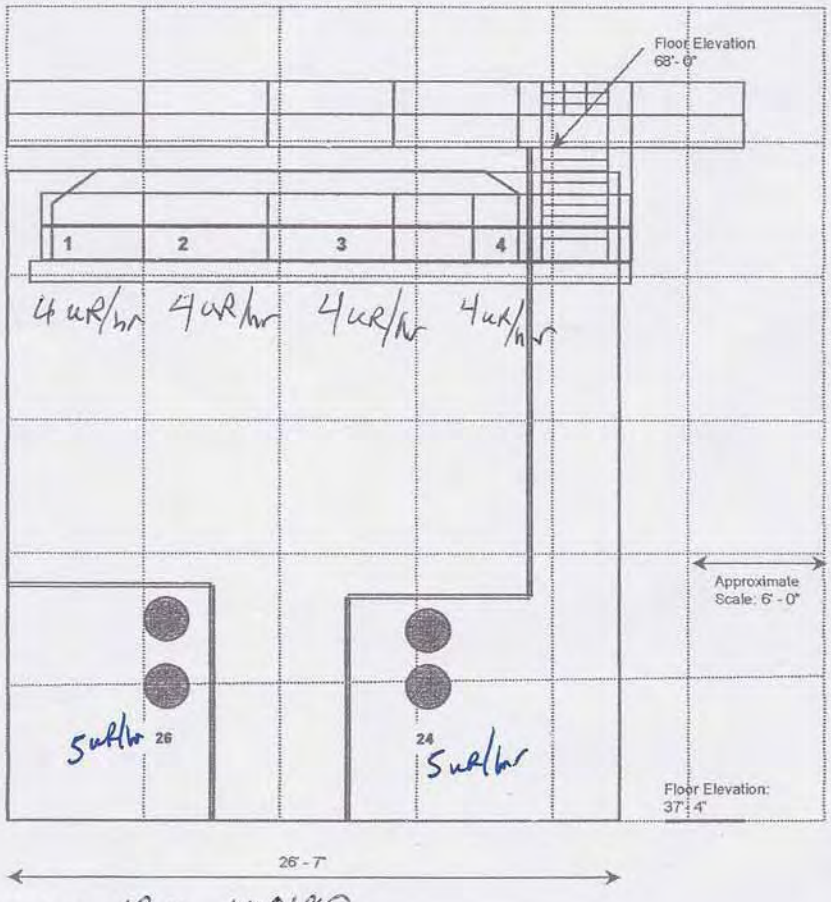
Map key: ° = Sample Location ☐ = Air Sampler Location _ = Core Sample

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): 19 - 148190

Survey Technician(s): A. Luca

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1013 Task Number NA

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

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	5 / 2	61	921
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
5	Top Plug Face	See Smear Data	76		<MDA
6	Top Plug Face		73		<MDA
7	Top Plug Face		64		<MDA
8	Top Plug Face		73		<MDA
9	Top Plug Face		99		1,584
10	Top Plug Face		87		1,084
11	Top Plug Face		75		<MDA
12	Top Plug Face		63		<MDA
13	Top Plug Face		74		<MDA
14	Top Plug Face		75		<MDA
15	Top Plug Face		70		<MDA
16	Top Plug Face		~~74~~ 74		<MDA
17	Top Plug – Top Surface		66		<MDA
18	Top Plug – Top Surface		76		<MDA
19	Top Plug – Top Surface		65		<MDA
5 Dup	Duplicate		78		<MDA

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is total in dpm/100 cm²

Rev 2 (2/07)

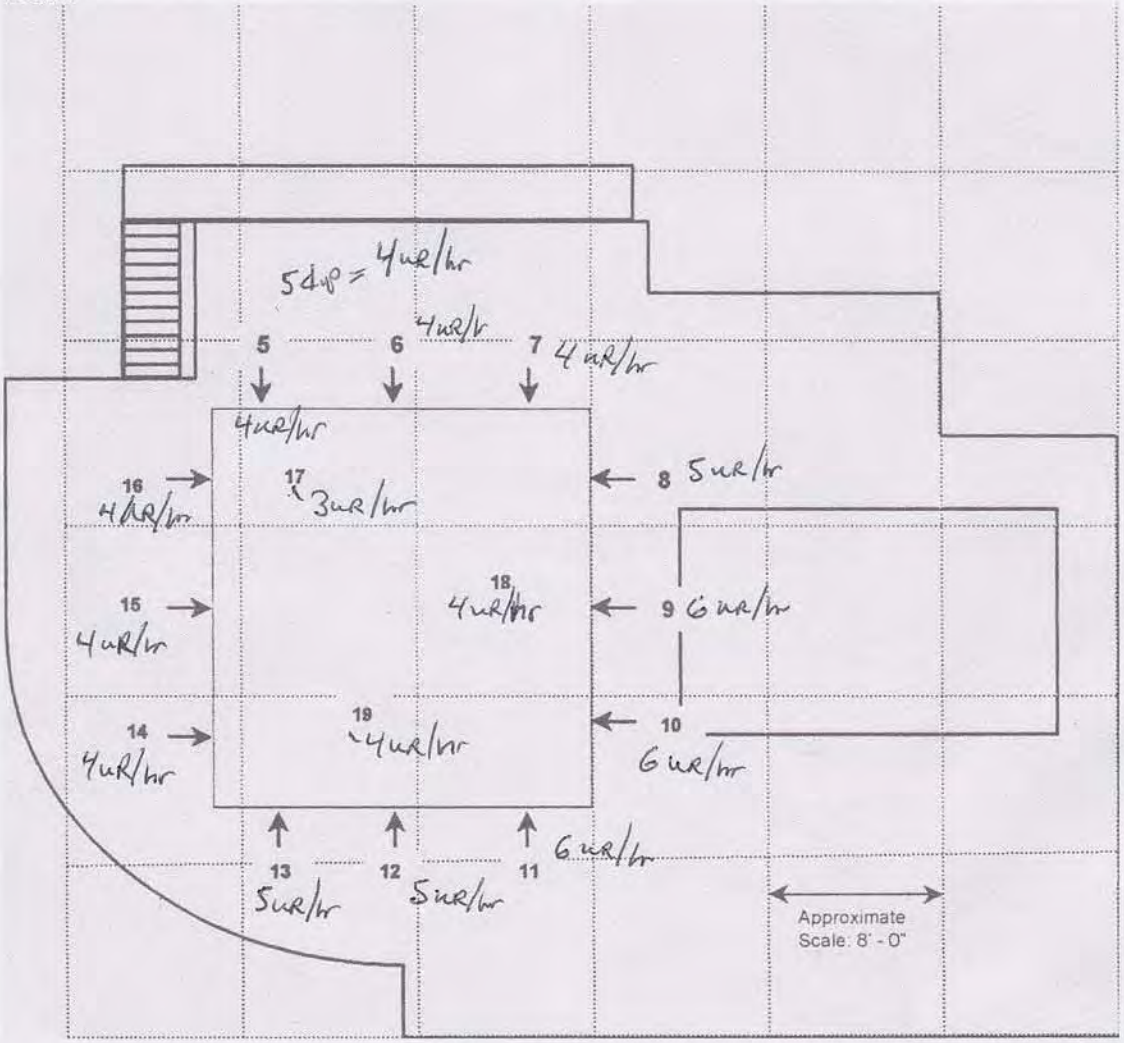
TECHNOLOGICAL MUSEUM DR. MODESTO IRIARTE BEAUCHAMP (former BONUS REACTOR FACILITY)
Rincón, Puerto Rico

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 1015	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

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

Sketch:



Instruments (Model and Serial Numbers): 19- 148190

Survey Technician(s): A. Lucca

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1330 Task Number NA

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

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	512	43	777
		/ /			/ /	%	/		

SURVEY DATA Survey Map Attached ☑ Yes ☐ No

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
20	Main Floor		59		<MDA
21	Main Floor	See	77		1,417
27	Main Floor	smears	493		18,759
28	Main Floor		2166	CW	88,503
27A	Main Floor		CW ~~76~~ 71	1,167	~~1,376~~
27B	Main Floor		77		1,417
28 Dup	Main Floor		2048		83,583

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is total in dpm/100 cm²

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4/Aug/11 14:35 Task Number N/A

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

Purpose of Survey: Year 2011 Comprehensive Survey A=(Sample-Bkg)/E x CF

156 = (X-51)/16
X = 76 cpm

Inst. Type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading (cpm)	MDA* dpm/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	10 / 1	51	156
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
65	Main Floor-Maslim (Zone 1)	49		<MDA	
*66	Main Floor-Maslim (Zone 2)	37		<MDA	
67	Main Floor-Maslim (Zone 3)	44		<MDA	
*68	Main Floor-Maslim (Zone 4)	56		<MDA	
69	Main Floor-Maslim (Zone 5)	52		<MDA	
72	Main Floor-Maslim (Zone 6)	40		<MDA	
*73	Main Floor-Maslim (Zone 7)	55		<MDA	
74	Main Floor-Maslim (Zone 8)	44		<MDA	
*75	Main Floor-Maslim Zone 9)	42		<MDA	
*76	Main Floor-Maslim (Zone 10)	38		<MDA	
77	Main Floor-Maslim (Zone 11)	53		<MDA	
*78	Main Floor-Maslim (Zone 12)	39		<MDA	
79	Main Floor-Maslim (Zone 14)	58		<MDA	
*80	Main Floor-Maslim (Zone 13)	42		<MDA	

Survey Technician: A. Luca
Reviewed By: [illegible]

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

$$MDA = \frac{\frac{2.71}{10} + 3.3\sqrt{\frac{51}{10} + \frac{51}{1}}}{16} = 156 \frac{cpm}{100\,cm^2}$$

Rev 2 (2/07)

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

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 1400	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

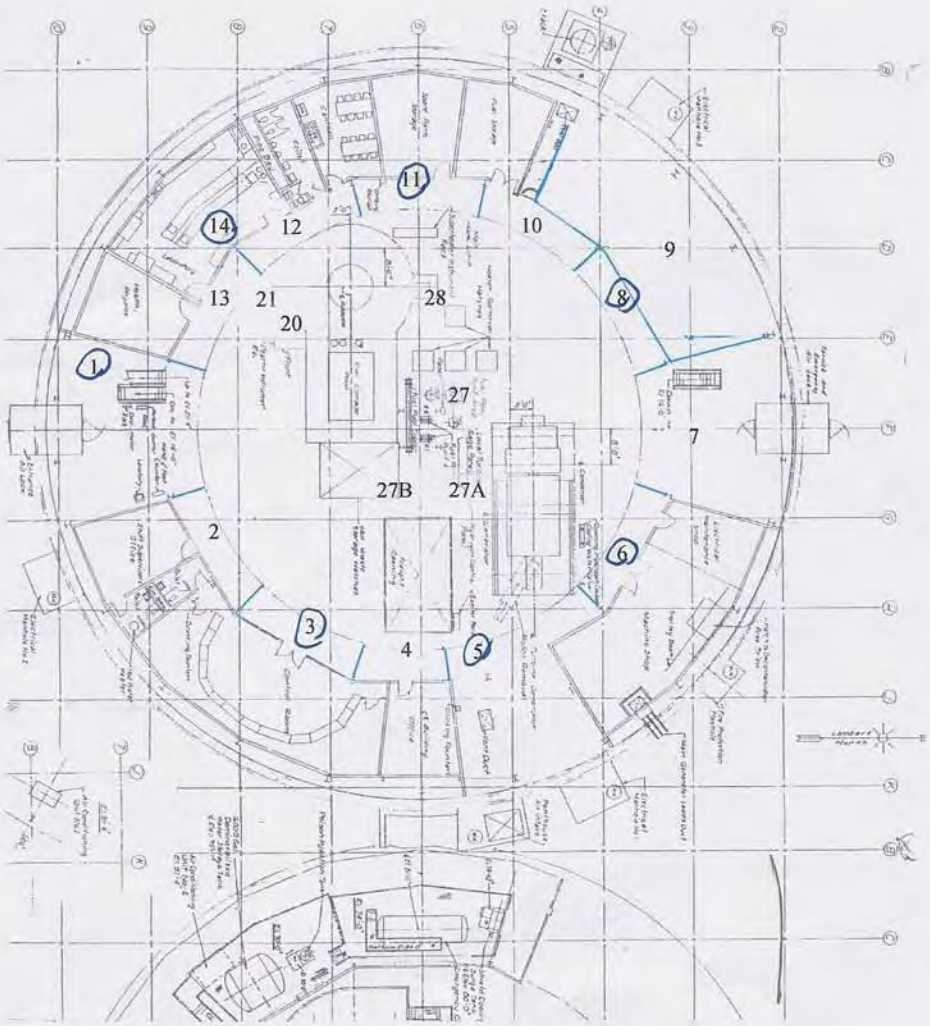
Map key: ° = Sample Location ☐ = Air Sampler Location _ = Core Sample

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	3
Zone 2= 66	5
Zone 3= 67	5
Zone 4= 68	5
Zone 5= 69	5
Zone 6= 72	5
Zone 7= 73	5
Zone 8= 74	5
Zone 9= 75	5
Zone 10= 76	5
Zone 11= 77	5
Zone 12= 78	4
Zone 13= 80	5
Zone 14= 79	5
Zone 14= dup	5
Zone __ =	
20	9
21	10
27	32
28	30
27A	10
27B	10
28dup	30



Instruments (Model and Serial Numbers): Model 19- 148190

Survey Technician(s): A. Luca

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1315 Task Number NA

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

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	5 / 2	43	777
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
22	South Side	—	41	—	<MDA

Survey Technician: A. Luca
Reviewed By: C. Webb

*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	4-Aug-11 Time: 1315	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

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

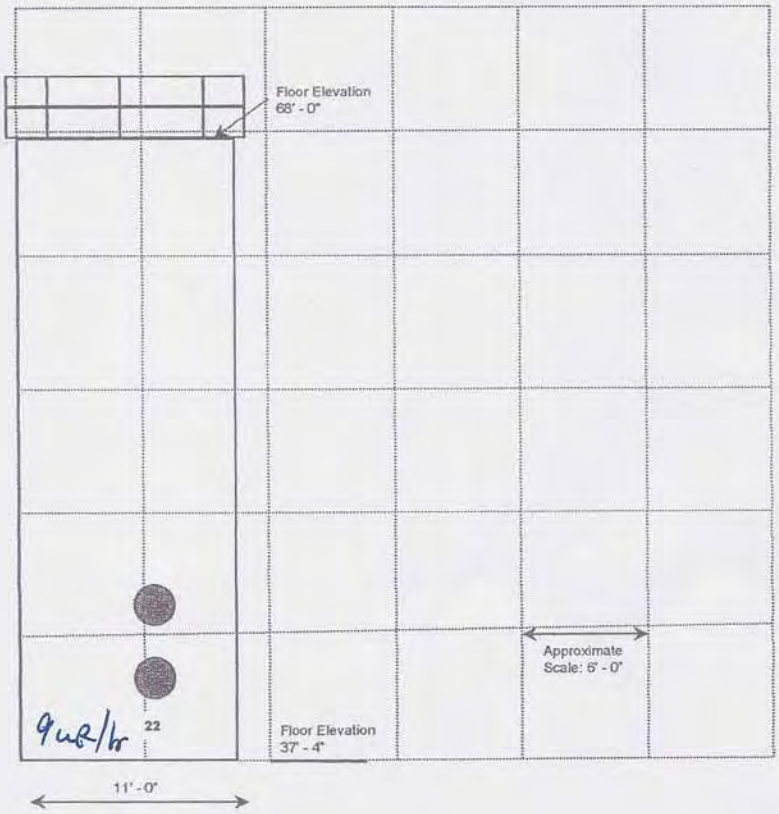
Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

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): A. Luca

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1400 Task Number NA

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

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	5 / 2	43	777
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
23	SouthWest Side	See smear Data	41	}	<MDA
23 Dup	"		36	}	<MDA
				}	

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is total in dpm/100 cm²

Rev 2 (2/07)

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

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 1400	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

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

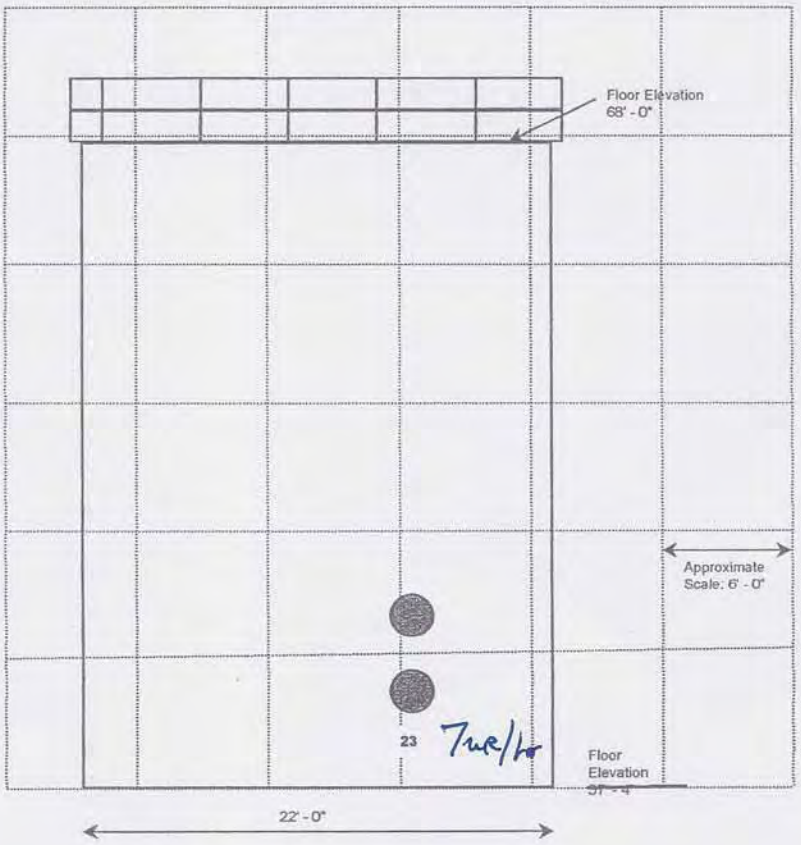
Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

Building: Entombed Reactor Building Location: SouthWest Side

Sketch:

Entombment System - Southwest View

1 = Sample Locations



Instruments (Model and Serial Numbers): Model 19 - 148190

Survey Technician(s): A. Luca

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1325 Task Number NA

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

Purpose of Survey: Year 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	5 / 2	43	777
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
25	NorthWest Side	—	34	—	<MDA

Survey Technician: A. Luca
Reviewed By: L. Webb

*MDA is total in dpm/100 cm²

Rev 2 (2/07)

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

RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 1325	Date: Yr 11 Mo 8 Dy 4
Task: Comprehensive Survey	RWP: NA	

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

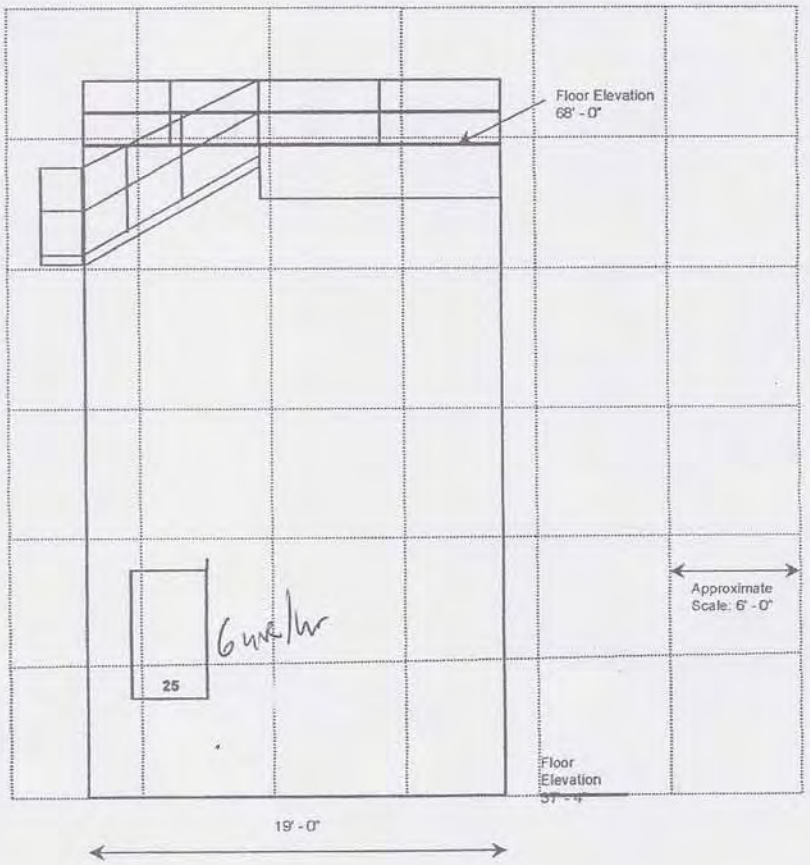
Dose Rate Abbreviations: CT/WB/GA, where CT = Contract, WB = Whole Body, GA = General Area

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): A. Luca

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 5-Aug-11 0835 Task Number NA

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 2011 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/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	5 / 2	44	786
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
30	Basement Floor-Side of Tank #1	See	75		1,292
31	Basement Floor-Side of Tank #2		80		1,501
40A	Basement Floor-Wall (4" from floor)	Smear	195		6,295
40B	Basement Floor-Wall (4" from floor)	data	54		<MDA
42	Basement Floor		41		<MDA
43	Basement Floor		43		<MDA
50A	Basement Floor-Wall (block)		48		<MDA
50B	Basement Floor-Wall (concrete)		49		<MDA
40ADup	Basement Floor-Wall (4" from floor)		179		5,628

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is total in dpm/100 cm²

$$\frac{\frac{2.71}{5} + 3.3\sqrt{\frac{44}{5} + \frac{44}{2}}}{.16} \times 6.67 = 786 \text{ dpm/100cm2}$$

63 cpm

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 5-Aug-11 1015 Task Number NA

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 2011 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	20/Apr/12	44-9	154535	20/Apr/12	16 %	10 / 1	50	155 for smears
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	βγ Total	α Removable	α Total
70	Maslim - Zone 1	52		<MDA			
71	~~Maslim~~ - Zone 2 smear	35		<MDA			
81	Maslim - Zone 3	41		<MDA			
89	~~Maslim~~ - Zone 4 Smear	55		<MDA			
90	Maslim – Zone 5	50		<MDA			
91	~~Maslim~~ – Zone 6 Smear	32		<MDA			
92	Maslim – Zone 7	45		<MDA			
93	~~Maslim~~ – Zone 8 Smear	44		<MDA			
94	~~Maslim~~ – Zone 9 Smear	42		<MDA			
95	~~Maslim~~ – Zone 10 Smear	43		<MDA			
96	~~Maslim~~ – Zone 11 Smear	38		<MDA			
97	~~Maslim~~ – Zone 12 Smear	52		<MDA			
98	~~Maslim~~ – Zone 13 Smear	50		<MDA			

Survey Technician: A. Zuca
Reviewed By: C. Lugo

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

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 5-Aug-11 1015 Task Number NA

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 2011 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	20/Apr/12	44-9	154535	20/Apr/12	16 %	10 / 1	50	155 for smears
		/ /			/ /	%	/		

SURVEY DATA **Survey Map Attached ☑ Yes ☐ No**

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
99	~~Maslim~~ – Zone 14 Smear	43		<MDA	
100	Maslim – Zone 15	41		<MDA	
101	~~Maslim~~ – Zone 16 Smear	50		<MDA	
102	~~Maslim~~ – Zone 17 Smear	46		<MDA	
103	~~Maslim~~ – Zone 18 Smear	38		<MDA	

Survey Technician: A Luca
Reviewed By: C Webb

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

Rev 2 (2/07)

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

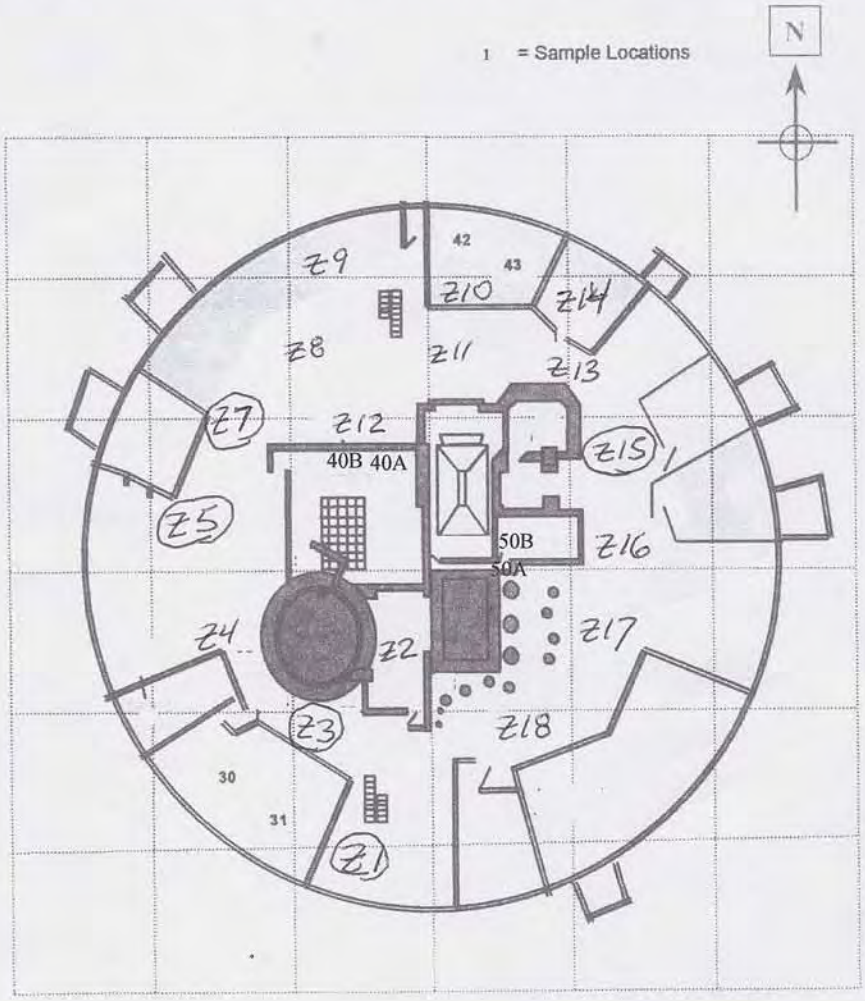
RADIOLOGICAL SURVEY REPORT (MAP)

SITE: Entombed Reactor Building	Time: 0915	Date: Yr 11 Mo 8 Dy 5
Task: Comprehensive Survey	RWP: NA	

Building: Entombed Reactor Building Location: Basement Floor

Sketch:

No.	µR/hr
Zone 1 = ~~71~~ 70	4
Zone 2 = ~~80~~ 71	5
Zone 3 = 81	7
Zone 4 = 89	5
Zone 5 = 90	3
Zone 6 = 91	5
Zone 7 = 92	5
Zone 8 = 93	5
Zone 9 = 94	6
Zone10 = 95	4
Zone11 = 96	4
Zone12 = 97	4
Zone13 = 98	5
Zone14 = 99	5
Zone15 = 100	4
Zone16 = 101	5
Zone17 = 102	5
Zone18 = 103	5
30	18
31	16
40A	30
40A Dup	30
40B	22
42	4
43	5
50A	10
50B	10
Zone 18 dup	5



Instruments (Model and Serial Numbers): Model 19- 148190

Survey Technician(s): A. Luca

Instruments (Model and Serial Numbers): _____

Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4-Aug-11 1435 Task Number NA

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

Purpose of Survey: Year 2011 Comprehensive Survey A=(Sample-Bkg)/E

156 = (X-51)/.16
MDA X = 76 cpm

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA* dpm/100cm²
Ludlum 2221	149991	20-Apr-12	44-9	154535	20-Apr-12	16 %	10/1	51	156
		/ /			/ /	%	/		

SURVEY DATA Survey Map Attached ☐ Yes ☒ No

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
1	Smears	46		<MDA	
2		46		<MDA	
3		44		<MDA	
4		51		<MDA	
5		45		<MDA	
6		40		<MDA	
7		57		<MDA	
8		39		<MDA	
9		43		<MDA	
10		53		<MDA	
11		40		<MDA	
12		37		<MDA	
13		62		<MDA	
14		44		<MDA	
15		54		<MDA	
16		48		<MDA	
16dup ~~17~~		49		<MDA	

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is removable in dpm/100 cm²

$$MDA = \frac{\frac{2.71}{10} + 3.3\sqrt{\frac{51}{10} + \frac{51}{1}}}{.16} = 156 \ dpm/100cm^2$$

 Rev 2 (2/07)

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 4/Aug/11 14:35 Task Number N/A

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

Purpose of Survey: Year 2011 Comprehensive Survey A=(Sample-Bkg)/E 156 = (X-51)/.16 X=76 cpm

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA* dpm/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	10/1	51	156
		/ /			/ /	%	/		

SURVEY DATA Survey Map Attached ☐ Yes ☒ No

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
17	smears	29		<MDA	
18		47		<MDA	
19		47		<MDA	
20		20		<MDA	
21		39		<MDA	
22		43		<MDA	
23		45		<MDA	
24		34		<MDA	
25		52		<MDA	
26		40		<MDA	
27		50		<MDA	
27A		39		<MDA	
27B		47		<MDA	
28		39		<MDA	
28		44		<MDA	

Survey Technician: A. Luca
Reviewed By: C. Webb

*MDA is removable in dpm/100 cm²

$$MDA = \frac{\frac{2.71}{10} + 3.3\sqrt{\frac{51}{10} + \frac{51}{1}}}{.16} = 156 \frac{cpm}{100\,cm^2}$$

Rev 2 (2/07)

$\frac{100\ cm^2}{15\ cm^2} = 6.67$

$$MDA = \frac{\frac{2.71}{10} + 3.3\sqrt{\frac{50}{10} + \frac{50}{1}}}{.16} \times 1 = 155\ \frac{dpm}{100\ cm^2}$$

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

Rincón, Puerto Rico **CONTAMINATION SURVEY FORM**

Project: BONUS - MMG Date/Time 5/Aug/11 9:26 AM Task Number N/A

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

Purpose of Survey: Year 2011 Comprehensive Survey A=(Sample-Bkg)/E

156 = (X-

155 = (X-50)/.16 → X = 75 cpm (MDA)

Inst. type	Serial #	Cal. due date	Probe type	Serial #	Cal. due date	Efficiency	Ct. Time Tbkg/Ts (minutes)	Bkgd Reading	MDA* dpm/100cm²
Ludlum 2221	149991	20/Apr/12	44-9	154535	20/Apr/12	16 %	10 / /	50	155
		/ /			/ /	%	/		

SURVEY DATA Survey Map Attached ☐ Yes ☑ No cw

No.	Description/Location	Gross Counts in CPM βγ Removable	Gross Counts in CPM βγ Total	Contamination in dpm/100 cm² βγ Removable	Contamination in dpm/100 cm² βγ Total
30	smears	29		<MDA	
31		52		<MDA	
40A		55		<MDA	
40B		40		<MDA	
42		58		<MDA	
43		57		<MDA	
50A		46		<MDA	
50B		43		<MDA	
40A dup		47		<MDA	

Survey Technician: A. Luna
Reviewed By: C. Webb

*MDA is removable in dpm/100 cm²

Rev 2 (2/07)

Attachment 3
Physical Condition - Inspection Checklist

Inspection Checklist
BONUS Decommissioned Facility, Rincón, Puerto Rico

Date of This Inspection/Revision: 4 August 2011
Last Inspection: 8/4/2011 30 September 2010
Inspectors: _____ and _____
Next Inspection (Planned): Summer 2012

No.	Item	Issue	Action
1	Specific site surveillance features	See attached table.	Inspect. ✓
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. ✓ Some cracks on Surface
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. piped OK
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. Access control is good.
5	Dome—Basement Level flooding	Water accumulating in Basement Level may mobilize and redistribute surface contamination.	Inspect for gasket and storm water drains. Gasket—poor condition Leak of loading door—see photos + last year's notes.
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. Access OK housekeeping OK entrance is posted
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 mezzazine; note general housekeeping. housekeeping OK Peeling paint water stain
8	Dome—exterior	Building should appear well maintained	Visually inspect. - Some flaking paint. corrosion on back entrance. "skirt" deteriorated + allowing water into basement.
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. ✓ none.
10	General site upkeep	Building should appear well maintained.	Observe and evaluate changes in site conditions. Fair condition some water damage. vegetation - not maintained.
11	Site security	Security guard should be stationed at site at all times.	Ensure security guard is present. ✓
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. ✓ ok. vegetation on slope to beach

see notes from last year

overhead crane dripping oil

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

Feature	Comment
Access road and parking area	Asphalt ok
Entrance gate	Motor-operated Not operable - Manually open/close.
Access through security gate	Note security of site; sign-in required on log sheet ✓
Security fence	Chain-link, topped with three strands of barbed wire - repair needed on beach-side
Dome—monolith plaques	Visually inspect ✓

Attachment 4
Calibration Sheets

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

UDLUM MEASUREMENTS, INC.
OST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER PUERTO RICO ELECTRIC PWR AUTHORITY ORDER NO. 20162613/355573

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

Mfg. Model Serial No.

Cal. Date 9-Oct-10 Cal Due Date 9-Oct-11 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 35 % Alt 708.8 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. (Min. Volt) 2.2 VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 525 V Input Sens. 33 mV Det. Oper. V at mV Threshold Dial Ratio = mV

☐ HV Readout (2 points) Ref./Inst. 500 / V Ref./Inst. 1000 / V

COMMENTS:
Cs-137 ≈ 1 µCi check source SN 2008 reads ≈ 270 uR/hr when placed flat against dimple on front of can with description facing out. (on 500 Range)

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 uR/hr	N/A	4000
5000	1000 uR/hr		1000
500	400 uR/hr = 71200 cpm		400
500	100 uR/hr		100
250	200 uR/hr = 36000 cpm		200
250	100 uR/hr		100
50	7120 cpm		40
50	1780 cpm		10
25	3600 cpm		20
25	900 cpm		5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

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/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1131 ☑ 781 ☐ 059 ☐ 280 ☐ 60646 ☐ 70897
Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ S105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 125489 ☐ Oscilloscope S/N ☑ Multimeter S/N 68260348

Calibrated By: Vicente Alvarado Date 9 Oct 10

Reviewed By: Robert Haines Date 10 Oct 10

☐ AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer PUERTO RICO ELECTRIC POWER AUTHORITY Date Order #. 20173630/361966

Model 2221 Serial No. 149991 Detector Model 44-9 Serial No. PR 154535

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Input Sensitivity 50 mV

Reference Point	"As Found" Readings (CPM): Analog	Range/Scale	After Adjustment Readings (CPM): Analog	Range/Scale
150 mR/hr	340	x 1k	340	x 1k
50 mR/hr	150	x 1k	150	x 1k
15 mR/hr	50	x 1k	50	x 1k
5 mR/hr	185	x 100	185	x 100
1.5 mR/hr	55	x 100	55	x 100
1.0 mR/hr	330	x 10	330	x 10

Reference Point	"As Found" Readings: Digital	Count Time	After Adjustment Readings: Digital	Count Time
150 mR/hr	34225	6sec.	34225	6sec.
50 mR/hr	14833		14833	
15 mR/hr	5221		5221	
5 mR/hr	1960		1960	
1.5 mR/hr	548		548	
1.0 mR/hr	332		332	

Signature: Duane Jackson Date 20-Apr-11

• *Serving The Nuclear Industry Since 1962* •

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER PUERTO RICO ELECTRIC POWER AUTHORITY ORDER NO. 20173630/361966

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

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR154535

Cal. Date 20-Apr-11 Cal Due Date 20-Apr-12 Cal. Interval 1 Year Meterface 202-159

Check mark ✓ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 38 % Alt 700.8 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. (Min. Volt) 5.0 VDC

✓ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

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 / 492 V Ref./Inst. 2000 / 2010 V

COMMENTS:

Sr90Y90:sn3432-09: Cs-137 #2008 reads as follows:32,250cpm IN 1MIN.
(61,100dpm) 15,131cpm ~~-Bg40 25%~~ with the source placed against protective screen of 44-9 detector.
Sr90Y90:sn4016= act= 36,309dpm,background=40cpm, source count=9,620cpm,Eff=26.4%
Co60:sn0886,act= 8,910dpm,background=40cpm,source count=1,177cpm,Eff=13.20%
Ni63:sn4017,act= 281,150dpm,background=40cpm,source count=360cpm,Eff=0.13%
Cs-137(gamma):sn0754,act= 175,706dpm,background=40cpm,source count=360cpm,Eff=0.20%
Cs-137(beta):sn158-112,act= 6,288dpm,background=40cpm, source count=1,320cpm,Eff=21%
All Efficiencies are in 4pi. and 1/4 inch from the surface of inhouse 180-2 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
X 1000	100 Kcpm		100
X 100	40 Kcpm		400
X 100	10 Kcpm		100
X 10	4 Kcpm	N/A	400
X 10	1 Kcpm		100
X 1	400 cpm		400
X 1	100 cpm		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*
Digital Readout	400 K cpm		40176cpm	Log Scale	500 K cpm		500k
	40 K cpm	N/A	4017		50 K cpm	N/A	50
	4 K cpm		402		5 K cpm		5
	400 cpm		40		500 cpm		500cpm
	40 cpm		4		50 cpm		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/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1131 ☐ 781 ☐ 059 ☐ 280 ☐ 60646 ☐ 70897

Cs-137 Gamma S/N ☐ 1162 ✓ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ✓ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

✓ m 500 S/N 189506 ☐ Oscilloscope S/N ✓ Multimeter S/N 93870637

Calibrated By: Duane Jackson Date 20-Apr-11

Reviewed By: Richard Hui Date 21 Apr 11

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

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