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Long-Term Surveillance and Maintenance Plan for the Boiling Nuclear Superheater (BONUS) Reactor Facility, Rincón, Puerto Rico

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U.S. DEPARTMENT OF ENERGY | Legacy Management

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Contents

Figures

Tables

Appendixes

Abbreviations

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
BONUS	boiling nuclear superheater
CFR	*Code of Federal Regulations*
Ci	curies
cm	centimeters
DOE	U.S. Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EM	Office of Environmental Management
FONSI	Finding of No Significant Impact
JSA	job safety analysis
km	kilometers
LM	Office of Legacy Management
LOA	letter of agreement
LTS&M	long-term surveillance and maintenance
m	meters
m^2	square meters
MDA	minimum detectable activity
µCi	microcuries
µR/h	microroentgens per hour
MOA	memorandum of agreement
mrem/year	millirem per year
MWe	megawatts net electric capacity
MWt	megawatts of thermal energy
PREPA	Puerto Rico Electric Power Authority
PRWRA	Puerto Rico Water Resources Authority
RPP	Radiation Protection Program
RPPP	Radiation Protection Program Plan
SCM	surface contamination monitor
UST	underground storage tank

1.0 Introduction

1.1 Purpose

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) provides long-term surveillance and maintenance (LTS&M) services for remediated DOE sites and other sites assigned to DOE to ensure that those sites remain protective of human health and the environment. Key components of these LTS&M services include stakeholder participation, site monitoring and maintenance, records information management, and research activities. This *Long-Term Surveillance and Maintenance Plan for the Boiling Nuclear Superheater (BONUS) Reactor Facility, Rincón, Puerto Ricco*, hereafter called the LTS&M Plan, explains how DOE and the Puerto Rico Electric Power Authority (PREPA), as partners in postclosure care, will maintain protection of human health and the environment and comply with applicable laws and regulations at the former boiling nuclear superheater (BONUS) reactor facility in Rincón, Puerto Rico.

1.2 Background

In 1960, the U.S. Atomic Energy Commission (AEC), the predecessor to DOE, contracted with the Puerto Rico Water Resources Authority (PRWRA), the predecessor to PREPA, for the construction and operation of the BONUS reactor. The reactor was constructed from 1960 to 1964 through a combined effort of AEC and PRWRA. The BONUS reactor was one of only two boiling-water superheater reactors ever developed in the United States and was established to evaluate the effectiveness of this reactor design. This small-scale prototype nuclear reactor design produced saturated steam in the central portion of the reactor core. The steam was superheated in four surrounding superheater sections in the same core, and then the superheated steam was used in a direct cycle to drive a turbine generator. Steam characteristics matched the inlet requirements of a standard 17.3 megawatts net electric capacity (MWe) turbine generator designed for use in a fossil-fueled plant.

The experimental reactor operated intermittently from 1964 to 1968, after which operations were discontinued due to lack of funds, and the facility was decommissioned. Final facility conditions are documented in the *Boiling Nuclear Superheater Power Station Decommissioning Final Report* (PRWRA 1970). Decommissioning activities included (1) removal of all special materials (e.g., nuclear fuel) and certain highly activated components, such as control rods and shims, from the reactor and disposal of such materials and equipment on the United States mainland; (2) in-place entombment of the pressure vessel and associated internal components within a three-story-tall concrete monolith within the enclosed domed building; and (3) decontamination of contaminated systems outside the pressure vessel that were left in place. The facility was decontaminated to a safe occupational exposure condition in accordance with standards in place at that time (see Section 2.5 for current DOE standards). These activities were completed in 1970. Following decommissioning, a postdecommissioning surveillance program was implemented at the facility to monitor radiological and physical conditions (PRWRA 1970).

The DOE Office of Environmental Management (EM) at Oak Ridge, Tennessee, was responsible for postclosure care of the facility following decommissioning. EM worked with PRWRA to develop a memorandum of agreement (MOA) (DOE 2003c) with LM in March 2003. The agreement outlined that responsibility would be transferred to LM when remedial action was

completed. The MOA evolved into a letter of agreement (LOA) that was finalized and approved in August 2010. The LOA is provided in Appendix A and further discussed below.

The former BONUS reactor facility includes the enclosed domed building, which contains the entombed reactor system, and outside support facilities. Only fixed residual radioactive contamination is present in limited and discrete areas of the accessible areas in the enclosed domed building.

Because of the historical significance of the BONUS reactor, PREPA proposed to use the facility as a museum that would be open to the public. The main level, for which public access was proposed, has areas of fixed radioactive contamination. These areas have been isolated, shielded, and posted to protect visitors and workers from exposure to unacceptable levels of radiation. DOE conducted an Environmental Assessment that indicated there is no unacceptable risk to human health or the environment if the main floor is used as a museum, as long as the facility is maintained in its present condition (DOE 2003a). This conclusion is incorporated in a Finding of No Significant Impact (FONSI) (DOE 2003b). The FONSI is provided in Appendix B.

The LOA formalizes the relationship between LM and PREPA concerning radiation protection and radiation levels that remain at the site. Under the LOA, LM and PREPA agree to work together to manage the BONUS reactor. The LOA provides for monitoring and inspection support by PREPA and controlled public access to the BONUS reactor building when it becomes a museum. Both the reactor (main) level and basement (lower) level are available for public access. PREPA will continue to give DOE monitoring and technical competence support, in addition to inspections and frequent visual evaluations of the entombed reactor vessel. DOE will continue to meet its responsibilities of oversight and management of radioactive materials entombed in the reactor vessel.

1.3 Legal and Regulatory Requirements

As the successor agency to AEC and in accordance with the Atomic Energy Act of 1954, as amended, DOE holds title to and is responsible for the radioactive materials that remain at the former BONUS reactor facility. PREPA owns the land, facilities, and other improvements.

As the authorized custodian of the radioactive materials remaining at the BONUS reactor facility, DOE will comply with the following regulations and guidance:

Title 10 *Code of Federal Regulations* Section 835 (10 CFR 835), "Occupational Radiation Protection":
The rules in this section establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Subpart B of Section 835.101 states that an applicable DOE activity shall be conducted in compliance with a documented Radiation Protection Program (RPP), as approved by DOE. The content of each RPP shall be commensurate with the nature of the activities performed and shall include formal plans and measures for applying the as low as reasonably achievable (ALARA) process to occupational exposures.

DOE Order 458.1 Chg 4 (LtdChg), *Radiation Protection of the Public and the Environment*: This DOE order establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended.

PREPA shall maintain compliance with applicable portions of DOE Order 458.1 Chg 4 and 10 CFR 835 through its annual and quarterly monitoring of the BONUS facility for worker and public safety.

1.4 Policy

LTS&M of the BONUS reactor facility entails a partnership and acceptance of certain responsibilities by PREPA and DOE. DOE will manage radioactive materials for which it is responsible in accordance with this site-specific LTS&M Plan. DOE will also maintain the LTS&M Plan. If DOE proposes changes to the LTS&M Plan that involve PREPA's operations at the BONUS property, DOE will obtain PREPA's concurrence before implementing the changes.

The goal of the LTS&M program for the BONUS facility is to maintain protection of human health and the environment and preserve site information for future custodians. This entails:

- Keeping ionizing radiation exposure to employees, the public, and the environment ALARA.
- Keeping hazardous substances isolated from the environment.
- Maintaining compliance with applicable guidance, regulations, and laws.
- Ensuring that facility activities, events, and conditions are recorded for future stewards.
- Maintaining site records.
- Responding to questions and concerns from the public and other stakeholders.

2.0 Site Conditions

2.1 Area Description

Puerto Rico is approximately 1000 miles (1609 kilometers [km]) southeast of Miami, Florida, and approximately 500 miles (804.5 km) north of Venezuela. The topography of Puerto Rico is generally mountainous, except for the coastal areas. The BONUS facility is in the coastal lowlands near Rincón, Puerto Rico, on the western coast (Figure 1). Land use in the city of Rincón, 2 miles (3.2 km) southeast of the site, includes mixed residential and light commercial activities typical of a tropical beach community. The two major factories in Rincón are Medical Sterile Products, which manufactures surgical equipment, and Flexible Packing Company, which manufactures cardboard products. The 2022 population of Rincón was around 15,316 (U.S. Census Bureau 2022).

The regional climate is classified as tropical marine, consisting of warm temperatures and high humidity throughout most of the year. Near the BONUS facility, the average daily temperature is approximately 80 °F (27 °C). The National Weather Service in San Juan, Puerto Rico, has measured all-time maximum and minimum temperatures of 98 °F (36.7 °C) and 40 °F (4.0 °C), respectively. Depending upon location, average annual precipitation in the coastal regions ranges between 40 and 150 inches (101 and 381 centimeters [cm]) per year, with the northern coast receiving twice as much rain as the southern coast. Precipitation is greatest from April through November; the dry season occurs from December through March. Most of Puerto Rico's rainfall is orographic (i.e., moisture-laden air is cooled while ascending over the mountains, causing condensation in the form of rain). The prevailing wind direction over most of the island is from the east, although wind directions in some coastal areas exhibit diurnal variations.

Hurricanes are frequent between August and October. The most destructive hurricanes in the island's recorded history included Hurricane San Ciriaco in August 1899, Hurricane San Ciprian in September 1932, Hurricane Georges in September 1998, and Hurricanes Irma and Maria in 2017. In each case, the storm crossed Puerto Rico in a generally east-to-west direction and severely damaged the island. The enclosed domed building was designed to withstand wind velocities of 150 miles per hour (241.4 km per hour) (PRWRA 1970). No structural damage has been observed from storms to date, although Hurricane Georges caused flooding of the enclosed domed building basement when storm drains became plugged and the building's basement door seals leaked. The stormwater drains, which had debris from the original construction, were unplugged and the rubber door seals were replaced (after being in place for more than 28 years).

2.2 Site Description

The BONUS facility is on the westernmost coastal point (Punta Higuera) of Puerto Rico near a U.S. Coast Guard lighthouse (Figure 1). The facility lies within a 5-acre (2-hectare) fenced area surrounded by 137 acres (55 hectares) of undeveloped land primarily vegetated with brush, native pasture, and woodland. Formally known as the BONUS site (owned by PREPA), this area served primarily as a buffer zone when the plant was in operation. The chlorination plant, warehouses, and water tanks were also in this area. The 6-foot-high (1.8-meters [m]) chainlink security fence is topped with three strands of barbed wire.

Figure 1. Location of the BONUS Facility, Rincón, Puerto Rico

Access through the entrance gate is controlled by a full-time security guard who is contracted by PREPA and stationed in a guard shack (Figure 2). All visitors entering the facility must sign in on a log sheet. A paved road within the BONUS site provides access to the lighthouse and the BONUS facility.[1] Exterior lighting illuminates the site at night. Nearby businesses and adjacent beaches are popular tourist destinations. Low-density residential areas border the PREPA property.

The average elevation of the enclosed domed building is approximately 25 feet (7.6 m) above sea level. Because of the earthen embankment around the enclosed domed building, the effective ground level is approximately 40 feet (12 m) above sea level. The natural grade slopes down to the sea west of the facility and upward to the mountains on the east side of the facility.

The BONUS facility includes six main buildings—the enclosed domed building, entrance buildings (consisting of the building with bathrooms and lockers and the building with administrative offices, connected by a breezeway), auditorium (also known as the theater), Training Center building, and guard shack—and other smaller support structures and facilities. Figure 2 shows the general site layout.

Enclosed Domed Building: The enclosed domed building consists of three levels: the basement (Figure 3), main floor (Figure 4), and mezzanine. North and south entrances provide access to the main floor of the building. Both entrances are equipped with air-lock chambers between two steel security doors, and all doors are currently operational.

Basement: The basement is directly below the main floor and is posted as a radiologically controlled area. The two stairways to this level are posted and barricaded with expanded metal. A barricade of plexiglass and expanded metal on a steel handrail surrounds the area on the main floor that is open for moving fuel from transport trucks to the fuel storage facility. There are no museum displays in the basement. Another entrance (large enough for a truck to enter) is at the basement level; originally used for fuel handling, this entrance is now sealed.

Fixed radioactivity exists throughout this level. Removable radioactivity above the minimum detectable activity (MDA) but below the criteria for unrestricted release specified in DOE Order 458.1 Chg 4 was identified in some areas of the basement (see Section 2.5) and was removed or fixed in summer 2004. In accordance with the MOA (DOE 2003c), personnel from the EM Oak Ridge office covered fixed contamination on the floor with concrete before the transition to LM was finalized. Asbestos pipe insulation exists throughout the basement; however, PREPA asbestos-certified personnel have inventoried the pipe insulation and stabilized it in place (MACTEC-ERS 2002). Asbestos inspections are performed quarterly and air sampling is performed annually by PREPA staff or contractors.

Main Floor: On the center of the main floor is the turbine, the access to the basement for fuel handling, and the crane tower. The concrete monolith, which contains the reactor pressure vessel, rises through the main floor from the basement to the mezzanine level. Barricades constructed of plexiglass panels mounted on a steel hand railing surround the center area and restrict public

[1] Originally, access to the entire 137 acres comprising the BONUS facility was controlled at a guard shack at the start of the paved road, where it joins with Road 413. Access control was reduced to the 5-acre zone as a request from PREPA to DOE so that the rest of the site (the 0.25-mile buffer zone) could be used for future development. As a result, access to the lighthouse was provided via the paved road and the lighthouse became a tourist attraction. Before that, access to the lighthouse was via the beach.

access due to fixed contamination. The control room, laboratories, support offices, shops, and storage areas are arranged against the outside wall. PREPA stores BONUS records describing plant design, construction, operation, and decommissioning in two climate-controlled rooms on this level, the former Mechanical Shop and Electrical Maintenance Shop. In 2018 remaining original site records were moved to the LM Business Center at Morganton, West Virginia.

The main floor has been developed into a museum. Numerous displays recount the history of the BONUS site, as well as the development of electric power and nuclear energy. In addition, information concerning the history of PREPA, Nobel Prize winners, scientists, the solar system, and space travel is discussed and pictured in displays. The reactor control room is still intact and, although it is inactive, control lights have been wired to display an operational effect. A computer learning room containing approximately 12 computer stations has been developed for the future purpose of student research on science topics.

Fixed radioactivity exists on the floor in several areas of the main floor. PREPA has placed ceramic floor tile over these areas to reduce exposure and prevent direct contact. Inside the barricaded center area, a concrete block (approximately 6 feet × 2 feet × 10 inches [183 × 61 × 25 cm] thick) and several lead blocks were placed over the fixed radiological contamination with the highest activity. No removable radioactivity above MDA is present on the main floor or walls.

Mezzanine: The mezzanine is above the main floor and provides access to the top of the former reactor, which is now a solid concrete monolith. Access to the mezzanine level is restricted. Access to the overhead crane controls is also on this level. There are no museum displays here. Several areas of fixed radiological contamination have been identified on the mezzanine's concrete floor and concrete monolith structure. No covering over the fixed radiological contamination exists. No removable contamination above MDA is present on the mezzanine floor or walls.

Entrance Buildings: These concrete-block buildings consist of the building with bathrooms and lockers and the building with administrative offices, separated by a covered breezeway. These buildings are on the south end of the enclosed domed building and may be accessed directly from the parking lot. They serve as the museum's main entrance. The administrative offices building contained offices, restrooms, and a conference room. During plant operations, this building also contained an auxiliary control room. It does not contain radiological contamination.

Auditorium: This concrete-block building is west of the enclosed domed building. It has an auditorium that is primarily used for training and meetings. During plant operations, it also contained a cafeteria and open-air dining area. It does not contain radiological contamination.

Training Center Building: This concrete-block building is north of the auditorium. It was used as office space and dormitories for visiting scientists when the facility was in operation. PREPA has no immediate plans for this building, but a history museum is being considered for this structure. It does not contain radiological contamination.

Guard Shack: This building, near the entrance gate, is used for site security and access control. It does not contain radiological contamination.

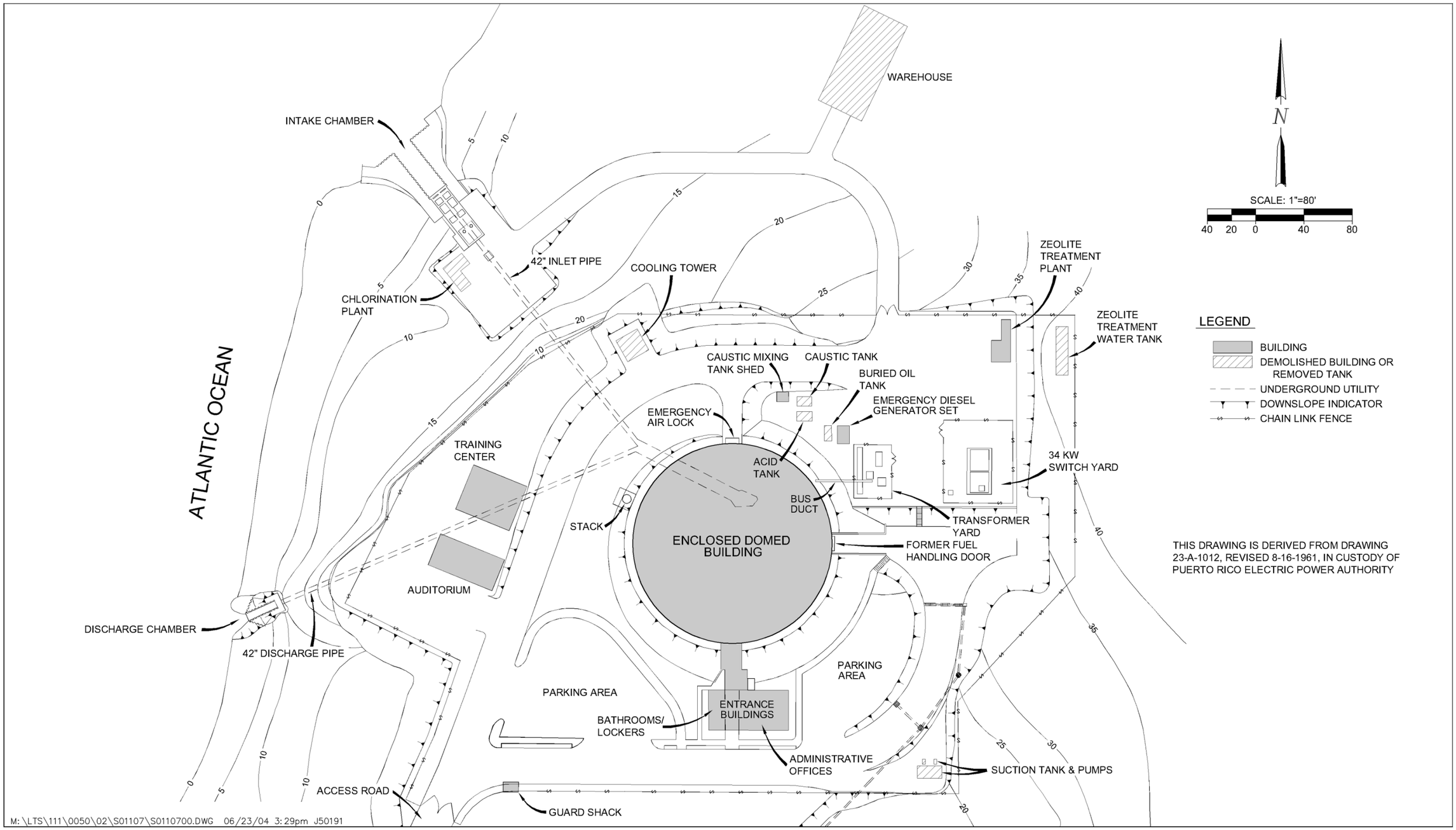

Figure 2. Site Layout of BONUS Facility, Rincón, Puerto Rico

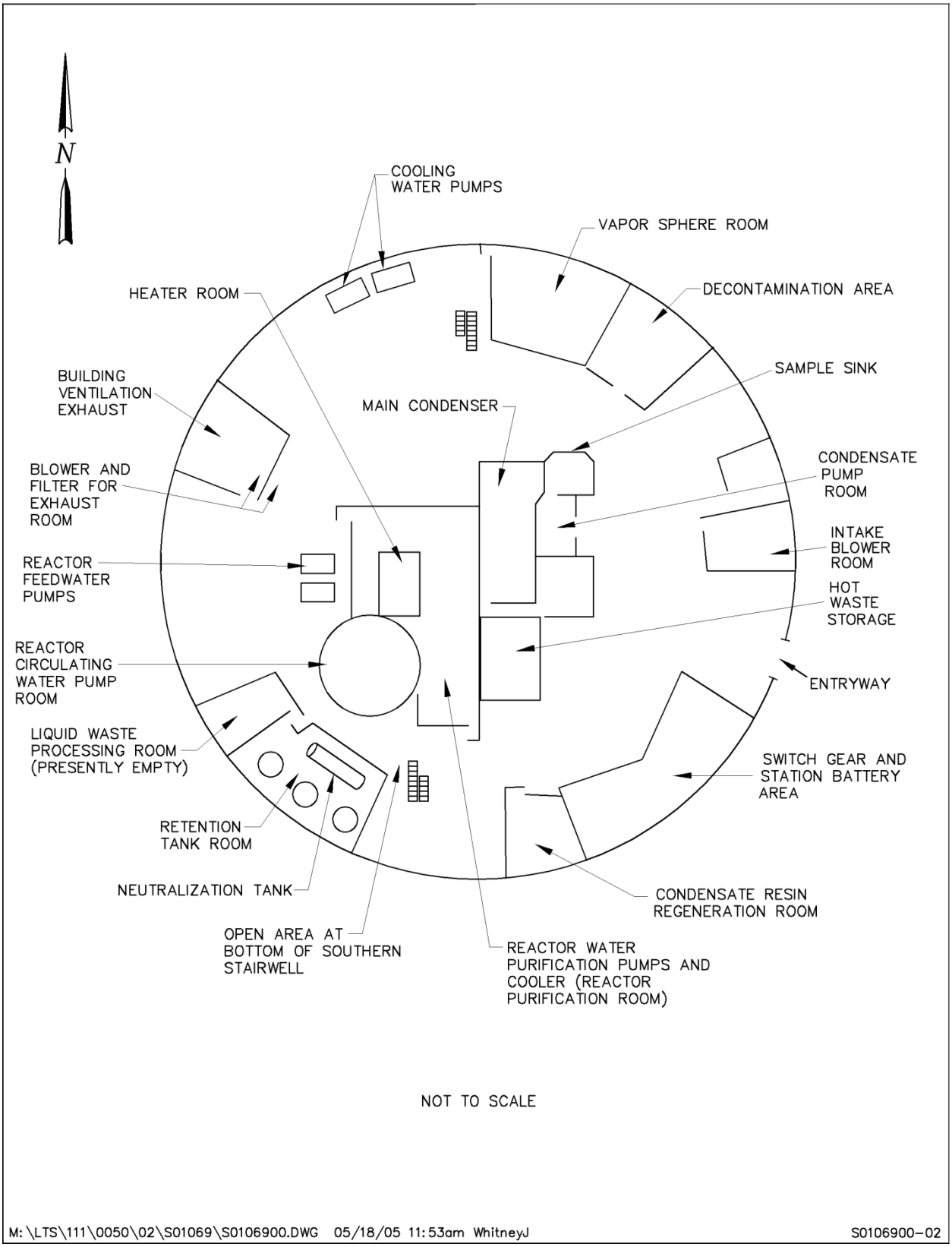

Figure 3. Basement Level of the BONUS Enclosed Domed Building, Rincón, Puerto Rico

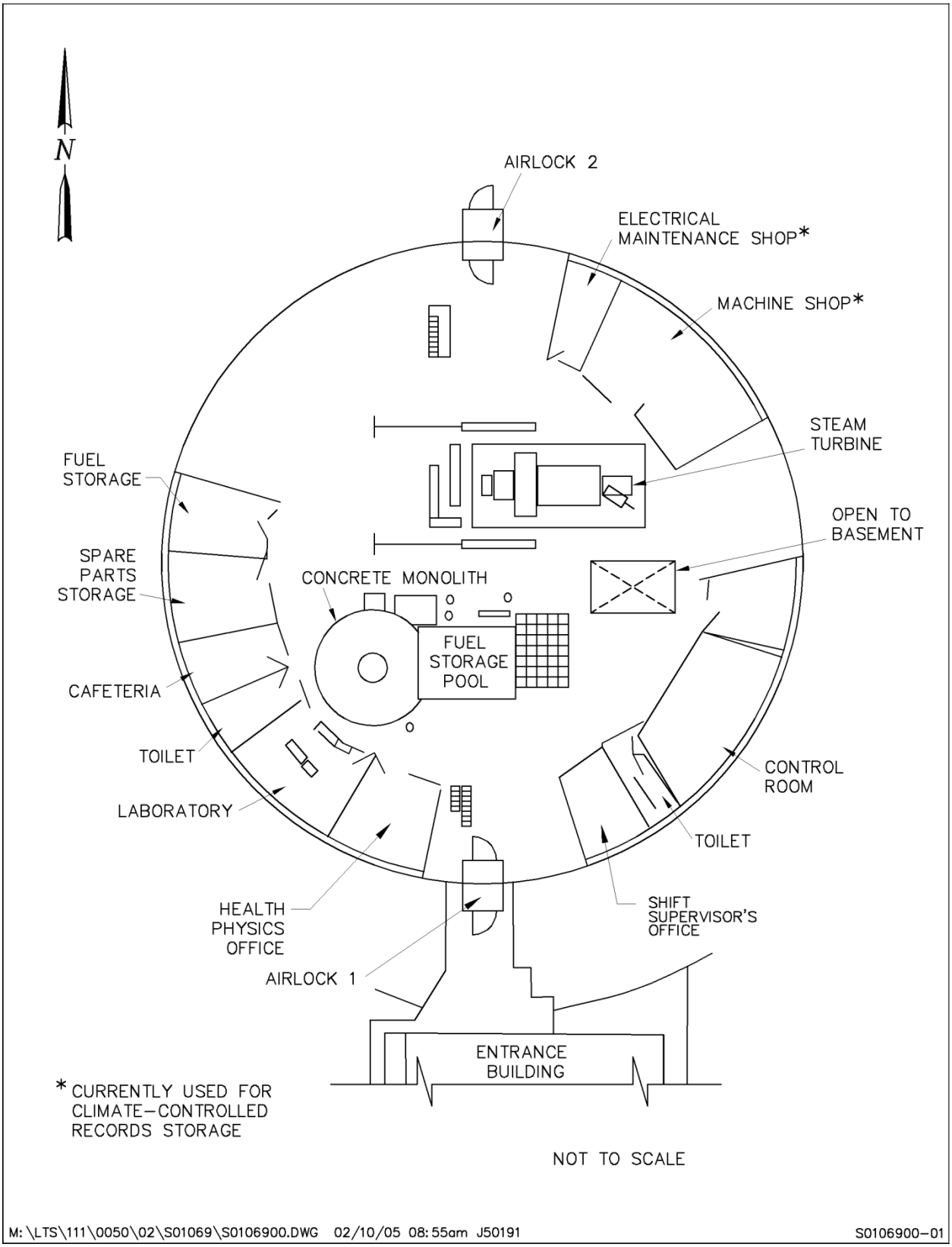

Figure 4. Main Floor of the BONUS Enclosed Domed Building, Rincón, Puerto Rico

Other Improvements:

Underground Storage Tanks (USTs): On the west side of the entrance buildings are two concrete USTs owned by PREPA. The USTs contain trace amounts of radiologically contaminated sludge containing cesium-137. The contamination was fixed in place by filling the USTs with Portland cement grout.

Access Road: The access road to the site is 0.66 mile (1 km) long, 26 feet (8 m) wide, and has a maximum grade of 3%. It leads from State Road 413 through the lighthouse parking lot, through the facility entry gate, and ends at the facility parking lot.

Entrance Gate: The entrance gate near the guard shack is 24 feet (7.3 m) wide and is motor operated.

Security Fence: A 6-foot-high (1.8 m) chainlink fence, topped with three strands of barbed wire, encloses the 5-acre site.

Parking Areas: Two parking lots, west and east of the entrance buildings, can accommodate 100 vehicles. They are constructed with a crushed stone base topped with bituminous asphalt pavement.

Landscaping: Landscaping consists of approximately 27,770 square feet (2580 square meters [m^2]) of grass that is planted in the areas between the sidewalks, parking areas, and the enclosed domed building.

Former Electric Substation: The electric substation that connected the BONUS facility to the Puerto Rico electric grid is in the northeast corner of the site. It is still in place but not operational. A 6-foot-high (1.8 m) galvanized steel chainlink fence with a 12-foot-high (3.7 m) gate encloses this area.

Water Supply: During site operations, the main source of raw water was well No. 3, located 675 feet (206 m) south and 293 feet (89 m) west of the enclosed domed building. The well is 60 feet (18 m) deep and was pumped at a rate of 25 gallons (94.6 liters) per minute. Today, water at the site is provided by the Puerto Rico Aqueduct and Sewage Authority.

Zeolite Treatment Plant Housing: This structure housed the zeolite treatment plant that was used for chemically treating city and well water. It is a reinforced concrete and block structure that measures 29 × 16 feet (9 × 5 m). Only the concrete structure remains today.

Drainage System: This system collects stormwater through a series of intercepting catches and basins, directs the flow through underground piping, and discharges it at low points of natural drainage.

Seawater Structure and Tunnels: These structures, west of the enclosed domed building, received and discharged seawater for condensate water cooling. Rectangular channels beneath the enclosed domed building foundation mat are connected to these structures by 42-inch (107 cm) reinforced concrete pipelines. The structures are now filled with sand to prevent access to the plant for security and safety reasons.

Site Lighting: The site's area lighting system is currently powered by PREPA's existing infrastructure outside of the facility.

Fire Protection System: PREPA replaced the original outdoor fire protection system. The current system consists of new fire hydrants, smoke alarms with laser sensors in the main floor of the enclosed domed building, fire extinguishers, emergency and exit lights, and new fire hoses in the entrance and auditorium buildings.

2.3 Location and Access

Figure 1 shows the location of the site in relation to local features and roads. Access to the site is granted by PREPA. The contact for accessing the site is:

Acting Supervisor
Puerto Rico Electric Power Authority
Rincón, Puerto Rico
(787) 289-4989 or (787) 289-4988

2.4 Site History

The BONUS facility was developed as a prototype nuclear power plant to investigate the technical and economic feasibility of the integral boiling-superheating concept. It was the eighth nuclear plant constructed in the world. The facility was designed to be large enough to evaluate the major features of the integral boiling-superheating concept in a realistic manner without the high construction and operating costs associated with a large plant. The facility was constructed under the joint sponsorship of AEC and PRWRA. Startup and initial operations were performed by Combustion Engineering Inc., but PRWRA had responsibility for long-term operation.

Construction of the facility occurred from 1960 to 1964. The BONUS reactor first went critical on April 13, 1964. The reactor underwent a series of criticality tests and then was operated experimentally at various power levels, first as a boiler and later as an integral boiler-superheater. Full-power (50 megawatts of thermal energy [MWt]), full-temperature (900 °F [482 °C] steam) operation was achieved in September 1965, and tests demonstrated satisfactory operation at 10% overpower in November 1965 (West and Fragoso 1966). It should be noted that 1 MWt is approximately equal to 3 MWe, and 1 MWe is equal to 14 million watts of electric capacity.

The boiling portion of the BONUS reactor contained 64 fuel assemblies at the center of the core. Each assembly contained 32 fuel rods in a 6 × 6-foot square array with the 4 central rods omitted. The superheating portion of the reactor consisted of four rectangular sections, one section along each side of the boiling zone. Each superheater section contained eight superheater assemblies, and each assembly contained 32 fuel rods. At normal full-power conditions, the boiling section produced 37 MWt of heat and generated saturated steam at a pressure of 985 pounds per square inch. The superheater section produced 13 MWt of heat. In making four passes through the superheater assemblies, the steam was heated to 900 °F (482 °C). Details of the reactor's operations are described in "BONUS Operating Experience"

(West and Fragoso 1966) and *BONUS Nuclear Electric Generating Station in Puerto Rico* (PRWRA 1965).

Operation of the BONUS facility was terminated in June 1968 because of technical difficulties that would have required high-cost modifications to fix. Decommissioning of the facility was conducted from 1969 to 1970. During decommissioning, all special nuclear materials (fuel) and certain highly activated components (e.g., control rods and shims) were removed, all piping systems were flushed, the reactor vessel and associated internal components within the biological shield were entombed in concrete and grout, and systems external to the entombment were decontaminated. Many contaminated and activated materials were placed in the main circulation pump room beneath the pressure vessel and entombed in concrete (PRWRA 1970). Piping was cut off at the concrete floor or biological shield, and penetrations were welded shut and grouted. Concrete monolith drawings are in the DOE site record, and final decommissioning conditions are documented in the *Boiling Nuclear Superheater Power Station Decommissioning Final Report* (PRWRA 1970). General decontamination of the facility was performed with the goal of meeting unrestricted use criteria in all accessible areas of the facility (later radiological surveys determined that unrestricted use criteria were not met). Residual radioactive materials remaining in the facility were isolated or shielded to protect site visitors and workers.

A stainless steel time capsule, containing decommissioning documents and drawings, was placed in the concrete monolith for future recovery. It is 19.5 feet west and 12.5 feet south of the top of the concrete monolith center located at the mezzanine. A plaque containing the following text, in English and Spanish, was embedded in the surface of the concrete directly over the time capsule.

> BONUS NUCLEAR POWER FACILITY
> Decommissioned 1970
>
> Entombed in this structure are radioactive materials which could be hazardous if exposed. Entry is prohibited without specific authorization from appropriate officials of the Commonwealth of Puerto Rico. If the structure is breached, vacate the premises promptly and notify the Public Health Department of the Commonwealth of Puerto Rico immediately.
>
> A capsule containing drawings and technical data relative to this facility is buried in the structure. Its location and a description of its contents may be found in the records of the Puerto Rico Water Resources Authority, Main Office, at San Juan, Puerto Rico.

Estimates of the radiological inventory in the concrete monolith following decommissioning in 2001 are presented in Table 1. Estimates of the radiological inventory in the piping and other systems external to the concrete monolith entombment following decommissioning are presented in Table 2. Following completion of decommissioning operations, approximately 53,000 curies (Ci) of radioactivity were contained within the concrete monolith, and approximately 0.013 Ci was contained in the form of scale in piping and components external to the concrete monolith (PRWRA 1970). Present-day radiological inventories are reduced, as a consequence of radioactive decay, to less than 900 Ci within the monolith and less than 900 microcuries (μCi) in the external systems. As shown in Table 1 and Table 2, nickel-63 is the predominant radionuclide remaining in the entombed materials, and cesium-137 is the predominant radionuclide remaining in the external systems.

Table 1. Estimates of Principal Radionuclides Entombed in the Concrete Monolith

Radionuclide	Half-Life	Activity (Ci)		
		August 1968 (PRWRA 1970)	2001	August 2016
Cobalt-57	271 days	2229	0	0
Cobalt-60	5.27 years	15,581	203	28.3
Nickel-63	100.1 years	840	669	602.5
Manganese-54	312 days	1023	0	0
Iron-55	2.7 years	33,586	7	0.15
Total	—	53,259	879	630.95

Source: PRWRA (1970).

Table 2. Estimates of Principal Radionuclides in the Decommissioned Systems External to the Entombment

Radionuclide	Half-Life	Activity (Ci)		
		1968 (PRWRA 1970)	2001	August 2016
Manganese-54	312 days	0.00011	—	—
Cobalt-60	5.27 years	0.010	0.00017	0.000018
Zinc-65	244 days	0.0016	—	—
Silver-110m	250 days	0.0000084	—	—
Antimony-125	2.77 years	0.000038	—	—
Cesium-137	30 years	0.0015	0.00071	0.00049
Total	—	0.013	0.00088	0.000508

Source: PRWRA (1970).

The design life of the entombment system is 140 years. After that period, PRWRA (1970) estimated that the largest contact dose level at any point within the entombment system would be decayed to 0.2 millirem per hour. Table 3 lists the activities of the principal radionuclides entombed in the reactor vessel as a function of time.

Table 3. Activity of Principal Radionuclides Entombed in Reactor Vessel as a Function of Time (in Curies)

Radionuclide	August 1968	+10 Years	+20 Years	+50 Years	+100 Years	+140 Years
Cobalt-57	2229	0.184	1.5×10^{-5}	—	—	—
Cobalt-60	15,581	4154	1107	21	2.83×10^{-2}	1.43×10^{-4}
Nickel-63	840	778	721	573	392	288
Manganese-54	1023	0.172	2.88×10^{-5}	—	—	—
Iron-55	33,586	185	1.02	—	—	—

Source: PRWRA (1970).

Radioactive materials removed during decommissioning were transported to an approved offsite disposal facility near Oak Ridge, Tennessee. Following completion of decommissioning activities, AEC and PRWRA entered into another contract (AT-[40-1]-4186) in 1971 (AEC 1971) for the surveillance and maintenance of the reactor containment system and monitoring of radiation at the facility. This new contract terminated contract AT-(40-1)-2672, under which the BONUS facility was constructed and operated. It established, among other provisions, that (1) with funding from AEC, PRWRA would conduct radiological monitoring; (2) the radioactive materials would be entombed in place; (3) PRWRA would not disturb the entombed radioactive materials; (4) PRWRA would provide monitoring and maintenance of the containment system; (5) the contract would be self-renewing for periods of 1 year; and (6) PRWRA would comply with AEC requirements for occupational and public safety. Also in accordance with this contract, the components and materials contained within the entombed structure remained the property of DOE. During the 1990s, the contract ceased to be administered, and maintenance and monitoring were performed by the EM Oak Ridge office. Radiological monitoring and surveillance have continued at the facility to ensure the protection of public health and the environment, even though the potential for radiological exposure of the public is considered to be low.

An LOA was signed in 2010 that formalizes the relationship between LM and PREPA as it relates to radiation protection and radioactivity levels remaining at the site. The LOA is provided in Appendix A. The LOA states that LM and PREPA will work together to manage the BONUS reactor and provides for controlled public access to the BONUS reactor building for the purpose of a museum, as well as monitoring and inspections support by PREPA. Both the reactor (main) level and basement (lower) level are available for public access. PREPA will continue to give DOE monitoring and technical competence support, in addition to conducting inspections and frequent visual evaluations of the entombed reactor vessel. DOE will continue to meet its responsibilities of oversight and management of radioactive materials entombed in the reactor vessel. Additional responsibilities are presented in Section 3.0 of this LTS&M Plan.

2.5 Summary of Radiological Conditions at the BONUS Facility

Radiological conditions following decommissioning of the facility are documented in the *Boiling Nuclear Superheater Power Station Decommissioning Final Report* (PRWRA 1970). Following decommissioning of the facility, United Nuclear Corporation collected 284 smears from floor and wall surfaces of the enclosed domed building. Removable beta-gamma radiation activity[2] levels were measured and ranged from nondetect to 418 disintegrations per minute per 100 square centimeters (dpm/100 cm^2). An additional 120 smears were collected at various locations on the entombment structure, and results from these measurements ranged from nondetect to 107 dpm/100 cm^2 beta-gamma radiation; gamma radiation exposure rate

[2] Radioactivity on building and equipment surfaces is measured in units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Removable activity refers to that portion of the total radioactivity that is accumulated by wiping a cloth or paper "smear" across the surface. DOE has specified criteria for acceptable levels of surface radioactivity for several categories of radionuclides. Because the primary radionuclides of concern (Table 1 and Table 2) at the BONUS facility emit only beta particles, gamma radiation, or both, the beta-gamma radiation category is the appropriate point of comparison. The guidelines for allowable residual surface contamination for unrestricted release for this category of radionuclides are specified in DOE Order 458.1 Chg 4 as 5000 dpm/100 cm^2 for total activity and 1000 dpm/100 cm^2 for removable activity.

measurements[3] at these locations ranged from 10 to 150 microroentgens per hour (μR/h). Soil samples were collected along the beach in the area of the discharge tunnel and close to the enclosed domed building; no radionuclides were found at detectable quantities in any sample.

Postdecommissioning surveys have been conducted annually and have not indicated increases in radiation levels. Some observations have been noted about concerns from weathering on the outside of the structure, extensive overgrowth around the facility, the presence of friable asbestos, and flooding of the basement, which prevented sampling during one reporting period.

Another radiological survey was conducted in 1996 to evaluate levels of residual radioactivity in the facility (Auxier and Associates Inc. 1997). Residue samples were collected from the facility to identify radionuclides of concern and their relative abundances. The primary radionuclide was cesium-137 (72%), but smaller quantities of nickel-63 (22%), strontium-90 (3%), and cobalt-60 (3%) were also present. Strontium-90 was not identified as a contributor to the radionuclide inventory in the decommissioning report but was identified as a minor contributor in the Auxier and Associates Inc. (1997) analysis.

Gamma radiation exposure rate measurements inside the enclosed domed building indicated radiation levels ranging from 5 to 9 μR/h in the entrance building, 5 to 10 μR/h on the basement floor, 4 to 6 μR/h on the main operating floor, and 3 to 8 μR/h on the mezzanine and upper surfaces of the reactor. These results are similar to the natural background exposure rate range of 3 to 10 μR/h at this site. Elevated radiation levels were found on the basement and main operating floors in isolated locations, most of which were associated with liquid handling systems or larger reactor components. The maximum gamma radiation exposure rate was measured at 500 μR/h on the north surface of the main operating floor entombment at a height of about 6 to 12 inches (15 to 30 cm) above the floor surface. Other components ranged from 15 to 30 μR/h on contact. Many of the plugged floor drains on the basement floor had elevated radiation levels on contact, but the levels decreased to the general area exposure rate range at approximately 3 feet (1 m) from the source.

During the 1996 survey, personnel also performed a general cleanup of the building and disposed of approximately 25 truckloads of materials from the facility, collected primarily from the former Health Physics Office, the former Chemistry Laboratory, and the former Shift Supervisor's Office (Figure 4). Removal of these materials was necessary to allow access to floor areas for the survey. It was estimated that these materials covered approximately 50% of the floor space and restricted access to the floor and lower wall surfaces for radiological characterization. Records related to BONUS facility operations and items or equipment of potential historical significance were segregated and retained. Visual inspection and radiological survey measurements were used to identify low-activity sources and contaminated materials that were not suitable for unrestricted release. Such items generally were relocated to the former Health Physics Office for further evaluation and disposition by PREPA. Items containing other (nonradioactive) potentially hazardous substances also were identified and generally relocated to the former Chemistry Laboratory for further evaluation and disposition by PREPA. No contamination was detected on

[3]Exposure rate is a measure of the ionization produced by gamma radiation in air per unit time, with units of microroentgens per hour (μR/h). Because radiation is always present in the natural environment from cosmic and terrestrial sources, the measured exposure rate should be compared to a site-specific background reading. The natural background exposure rate at the BONUS reactor facility ranges from 3 to 10 μR/h (Irizarry 1991) and averages 5 μR/h (DOE 1999a).

the other materials surveyed. Of these materials, 25 batches of BONUS-related records were retained in the former Shift Supervisor's Office, and the remainder were disposed of at an offsite landfill as nonhazardous waste.

In 1997, Shonka Research Associates Inc. (1997), under subcontract to the Jacobs Environmental Management Team, conducted a detailed characterization survey to assess the levels of radioactivity remaining at the BONUS facility. This survey evaluated 100% of accessible floor surfaces and the building walls to a minimum height of 1 m (3.3 feet) above the floor surface for fixed and removable beta-gamma radiation contamination. A survey of external gamma radiation exposure rates also was performed. Air samples collected within the building had no detectable airborne activity (the minimum detectable level was 9.9×10^{-12} µCi/milliliter). Soil samples were collected from areas adjacent to the building, and groundwater monitoring wells were installed to sample shallow groundwater. No radionuclides potentially attributable to BONUS operations were identified in the soil or groundwater samples. The relative abundance of radionuclides in a sample of dust collected from the basement floor was estimated at 88.66% cesium-137, 9.14% nickel-63, 1.36% cobalt-60, and 0.84% strontium-90. A summary of the surface contamination data is presented in Table 4.

Table 4. 1997 BONUS Enclosed Domed Building Radiological Measurements

BONUS Enclosed Domed Building Location	Surface Count Rate (dpm/100 cm^2)	Surface Activity (picocuries/m^2)			
		Cesium-137	Nickel-63	Cobalt-60	Strontium-90
Main reactor ring	1.98E+04	7.96E+05	8.21E+04	1.22E+04	7.54E+03
Reactor top and mezzanine	1.51E+05	6.09E+06	6.28E+05	9.32E+04	5.76E+04
Main rooms	9.25E+03	3.73E+05	3.84E+04	5.71E+03	3.53E+03
Center	1.74E+06	7.01E+07	7.23E+06	1.07E+06	6.64E+05
Basement	1.25E+05	5.02E+06	5.17E+05	7.68E+04	4.75E+04
Main floor visitor area	1.32E+04	5.31E+05	5.48E+04	8.13E+03	5.03E+03
Reactor floor	1.62E+05	6.55E+06	6.75E+05	1.00E+05	6.20E+04

Source: Shonka Research Associates Inc. (1997).

This surface contamination survey was conducted in a manner that ensured a detection limit of 1000 dpm/100 cm^2 averaged over 1 m^2. The survey was designed to identify localized areas of contamination (hot spots) with more than three times the average detection limit (or 3000 dpm/100 cm^2). The detection of such hot spots was difficult because of elevated and highly variable background radiation fields. Hence, some of the localized areas of elevated contamination reported in the survey at levels above 3000 dpm/100 cm^2 may actually be below the criterion. Where possible, survey personnel used a surface contamination monitor (SCM) device, which uses an array of computerized radiation detectors, including a position-sensitive proportional counter, to scan entire surface areas. Areas of elevated contamination exceeding release limits included portions of the basement, particularly the southwest quadrant of the basement, and localized areas of the main floor and mezzanine. Survey results included the following:

Auditorium: The auditorium was measured for fixed radioactivity in a single survey unit using the SCM. None of the 1 m^2 areas measured had average activity exceeding 1000 dpm/100 cm^2, and only a single 100 cm^2 area had activity exceeding the 3000 dpm/100 cm^2 criterion. This

reading was believed to be a false positive attributed to variability in background. In a survey for removable radioactivity, none was detectable in the auditorium.

Enclosed Domed Building, Basement: The floors of the basement rooms and open areas were surveyed for fixed radioactivity in a series of 29 survey units. Surveys also were performed for the lower walls (0–1 m [0–3.3 feet] above the floor). Most survey areas in the basement had one or more 1 m^2 sections where activity exceeded 1000 dpm/100 cm^2. The highest levels of contamination were found in the southwest quadrant of the basement around process equipment and appeared to be the result of a liquid spill.

Removable radioactivity was surveyed on the basement floors, walls (0–1 m [0–3.3 feet] above the floor), and reactor piping and equipment. Removable activity above the MDA was identified in several areas: along the southern side of the reactor, the Switch Gear and Station Battery Area, the Condensate Resin Regeneration Room, the open area at the bottom of the southern stairwell, the blower and filter for the Exhaust Room, and the 4000-gallon Retention Tank Room. Reactor equipment that had removable radioactivity included the tanks in the 4000-gallon Retention Tank Room, condensate pumps, Reactor Purification Room platform, sample sink, and basin beneath Shield Cooling Pump No. 2. The *Summary Report for the Radiological Survey of the Boiling Nuclear Superheat (BONUS) Research Reactor, Rincón, Puerto Rico* (Jacobs Environmental Management Team 1998a) provides a detailed summary of these results.

Enclosed Domed Building, Main Floor: The main floor was surveyed for fixed radioactivity using 42 survey units. The results indicated that 16% of the surveyed area exceeded the 1000 dpm/100 cm^2 guideline for activity averaged over 1 m^2, and 19% exceeded the 3000 dpm/100 cm^2 guideline. One area of radioactivity was found near the north face of the reactor under a pipe coupling. The highest reading in a 100 cm^2 area was over 12 million dpm/100 cm^2. This same area had the highest waist-high gamma radiation exposure rate of 50 µR/h (this location corresponds to the same area where Auxier and Associates Inc. [1997] measured 500 µR/h). Some of the radioactivity was removable and the areas were decontaminated to levels lower than 200 dpm/100 cm^2. The area of highest fixed radioactivity was covered with lead bricks to provide further exposure protection. The lower walls (0–1 m [0–3.3 feet] above the floor) were surveyed throughout the main floor; radioactivity above guidelines was found only along the north face of the concrete monolith.

As in the basement, there were various items on the main level that had levels of fixed radioactivity in excess of the guidelines. Some of these items had removable radioactivity but were decontaminated during the survey to levels below the most restrictive guideline. Fixed radioactivity on these items ranged from 1082 to 296,960 dpm/100 cm^2. One notable area was a sink near the main air lock. The *Summary Report for the Radiological Survey of the Boiling Nuclear Superheat (BONUS) Research Reactor, Rincón, Puerto Rico* (Jacobs Environmental Management Team 1998a) provides details of these results.

Concrete Monolith Top and Mezzanine: The concrete monolith top and mezzanine were surveyed for fixed radioactivity in a series of four units. Results indicated that 13% of the surveyed area exceeded the 1000 dpm/100 cm^2 guideline, and 12% exceeded the 3000 dpm/100 cm^2 guideline. The highest levels were found in a groove in the monolith top where the wheels of the crane move. Localized radioactivity of approximately 150,000 dpm/100 cm^2 was found. No fixed radioactivity was detected above guidelines on the

walls. No removable radioactivity above the MDA was detected on this level. The *Summary Report for the Radiological Survey of the Boiling Nuclear Superheat (BONUS) Research Reactor, Rincón, Puerto Rico* (Jacobs Environmental Management Team 1998a) provides details of these results.

Outside the enclosed domed building, the natural background gamma radiation exposure rate was estimated at approximately 5 μR/h at the site perimeter. All areas of the site had gamma radiation exposure rates similar to this rate with the exception of two areas: a location near the north emergency air lock, which had readings of 10 μR/h at 1 m, and a location near the reactor air exhaust stack, which had readings of 320 μR/h at contact with the ground surface and 17 μR/h at 1 m. The high readings at this second location were from two contaminated bolts. Readings returned to background levels after these bolts were removed.

Based on the results of this survey, the following recommendations were made to reduce the potential for exposure to radioactive material:

- Cover[4] the higher level of radioactivity measured on the floor near the north reactor face under the pipe coupling with a minimum of 10 inches (25.4 cm) of concrete to reduce the 1 m exposure rate to facility background levels.
- Sweep and mop the basement floor to collect loose radioactivity.
- Prohibit public access to the basement or ensure by some means (e.g., putting a security guard in place or raising the height of the plexiglass wall) that the public cannot climb over the plexiglass wall. Public access to other areas of the basement should also be prohibited, including the 4000-gallon Retention Tank Room, Condensate Pump Room, Reactor Purification Room, Reactor Feedwater Pumps, Condensate Resin Regeneration Room, and the Vapor Sphere Room; these rooms should be secured with a locking door or similar barrier to prevent public access.
- Paint or otherwise cover (e.g., tile) floors in all areas that will be accessible to the public to ensure that any residual radioactivity will remain fixed and does not become removable in the future. If paint is used, two coats of different colors should be applied so that it will be evident when the surface coat becomes worn.

PREPA completed all of these recommended actions in 1999. Additionally, in 2004, PREPA fixed removable contamination in the basement.

2.6 Geology

The BONUS site is in a coastal lowland area on the western coast of Puerto Rico, near Rincón. Thirty-one core holes were drilled to determine subsoil conditions during the design and construction of the enclosed domed building foundation slab. These cores indicated that the top stratum typically consisted of silty sand and cemented sand as sandstone in different degrees of strength and varying in thickness from 7 to 17 feet (2 to 5.3 m). Some sandstone required boring with a diamond drill. Underlying this upper stratum was a heterogeneous mass of sandy clay and

[4]In cases where residual radioactivity cannot be readily removed to achieve criteria, these areas may be covered to reduce potential radiation exposures. Cover materials may include paint, floor tiles, concrete, etc. The purpose of such materials is both to provide additional shielding that will reduce external gamma radiation exposure rates and to help ensure that the residual radioactivity remains fixed to building surfaces and does not become readily removable.

silt with pieces of limestone rock and silty clay or sand. Most of the borings terminated in a gray and brown silty clay stratum about 100 feet (30 m) deep (DOE 2002).

2.7 Seismicity

Puerto Rico is in an active seismic region (Zone 2 category). Numerous earthquakes have been recorded in this area, from 1615 to the present. The strongest earthquakes affecting Puerto Rico occurred in 1670, 1787, 1867, and 1918, resulting in numerous fatalities and severe economic damage (DOE 2003a). During 2000, 735 seismic events were detected in this region by the Puerto Rico Seismic Network (Puerto Rico Seismic Network 2015). The greatest seismic activity in 2000 occurred in May, with 51 events. Of these, only 2.3% were reported as felt. The largest earthquake during 2000, recorded at a magnitude 4.9 (Richter scale) and an intensity of IV (Modified Mercalli Scale), occurred on December 11. On the island of Puerto Rico, the most active region is south of an imaginary line that extends from Rincón to Guayama.

No evidence of damage (e.g., cracks, corrosion, wear, or deflections of concrete or metal components) to the BONUS facility as a result of seismic events has been identified to date. Because the 7-foot-diameter, 3-inch-thick steel reactor vessel and all associated piping and facilities have been filled with grout or concrete and encased in a reinforced concrete shell that is 10 feet wide, and because no liquid or gaseous materials are present that might be susceptible to release, the physical characteristics of the concrete monolith would not be susceptible to release of hazardous materials even in the event of structural damage from a severe earthquake or hurricane.

2.8 Surface Water

No surface water features are present at the BONUS site. The site is approximately 300 feet (100 m) inland from the Atlantic Ocean.

2.9 Groundwater

In the immediate area of the BONUS site, shallow groundwater occurs in a weathered limestone unit. Three monitoring wells installed at the site in 1997 intersected the water table at depths of approximately 23 to 40 feet (7 to 12 m) below ground surface (Jacobs Environmental Management Team 1998a; Jacobs Environmental Team 1998b).

2.10 Threatened or Endangered Species

The BONUS site that surrounds the facility lies within the range of the critically endangered hawksbill sea turtle (*Eretmochelys imbricata*) (Mortimer and Donnelly 2008), the endangered leatherback sea turtle (*Dermochelys coriacea*) (USFWS 2022), and the endangered Vahl's boxwood (*Buxus vahlii*) (Bárrios et al. 2021). The beaches adjacent to the site provide potential nesting habitat for the two species of sea turtles. A population of Vahl's boxwood is present on the property owned by PREPA adjacent to the BONUS facility. This plant species is known to exist only on Puerto Rico and the island of St. Croix in the U.S. Virgin Islands. The population adjacent to the facility is one of the five known locations of the plant on the island of Puerto Rico, as well as one of the largest.

3.0 Requirements of the LOA

The LOA formalizes the relationship between LM and PREPA concerning radiation protection and what remains at the site. LM and PREPA agree to work together to manage the BONUS reactor. Responsibilities and duties are listed in this section.

PREPA responsibilities include:

- Granting DOE right-of-entry to the PREPA property and improvements thereon for inspections, monitoring, consultation, and access to records, remedial investigations and activities, and other purposes. This right shall remain in effect for as long as radioactive materials at the BONUS facility exceed limits for unrestricted release, unlimited exposure, and unrestricted recycling or disposal.
- Implementing and maintaining an RPP. PREPA shall conduct radiological protection activities in accordance with the *Puerto Rico Electric Power Authority Radiation Protection Program Plan for the Boiling Nuclear Superheating Reactor Facility, Rincón, Puerto Rico* (DOE 1999a); *Puerto Rico Electric Power Authority Radiological Control Manual for the BONUS Reactor Facility, Rincón, Puerto Rico* (DOE 1998); *Sampling and Analysis Plan for the Boiling Nuclear Superheat (BONUS) Reactor Located in Rincón, Puerto Rico* (DOE 1999b); and *Standard Operating Procedures Under Revision for the BONUS Reactor Facility* (PREPA 1998).
- Complying with the reporting requirements specified for the RPP for the BONUS facility, including requirements for submitting duplicate records to DOE to be incorporated into the site collection.
- Supplying all equipment, supplies, and labor needed to perform the annual surveillance and maintenance duties identified in this LTS&M Plan and being responsible for the maintenance, calibration, and safety of such equipment in accordance with the *Puerto Rico Electric Power Authority Radiological Control Manual for the BONUS Reactor Facility, Rincón, Puerto Rico* (DOE 1998).
- Notifying DOE if radiological measurements indicate that standards or limits identified in the Radiation Protection Program Plan (RPPP) (including ALARA limits) are exceeded or if radiological survey results indicate a significant change in conditions and controlling dispersion of materials and access to and exposure from the affected areas until DOE management has responded to the notification.
- Conducting quarterly visual inspections of the facility and submitting quarterly inspection reports to the DOE project manager.
- Maintaining custody of records generated during routine or annual monitoring, surveillance, inspections, and nonroutine sampling and monitoring events, as well as maintaining custody of historical records, including records documenting construction, operations, and decommissioning.
- Maintaining control of the entire BONUS facility, protecting employees and the public by maintaining appropriate restrictions and controls for areas with contaminant levels above acceptable criteria, and controlling access to areas with physical hazards.

- Maintaining the site in a safe and structurally sound condition for access by workers and the public. Maintenance includes ensuring the integrity of any remaining asbestos encapsulation and preventing exposure to electrical and any other nonradiological hazards.
- Assuming all liability associated with use of the BONUS facility as a museum open to the public, including being responsible for any loss or destruction of, damage to, or redistribution of, DOE-owned property caused by the activities of PREPA.

DOE responsibilities include:

- Concurring (in writing) with plans and procedures, and in revisions to these documents, as they pertain to maintaining the radiological safety of visitors, workers, and the public at the BONUS facility.
- Auditing PREPA adherence to the RPPP (DOE 1999a) and other applicable guidance, policy, laws, and regulations.
- Conducting periodic inspections of the BONUS facility in accordance with this LTS&M Plan and submitting a written record of inspection results to PREPA.
- Documenting inspections and other site-related activities for the LTS&M site records collection and maintaining site records, including pertinent historical records and annual reports of site physical and radiological conditions, releases, and emergency responses, as part of the DOE LTS&M site records collection.
- Approving all activities that result in accessing contaminated or regulated material.
- Disposing of radioactive waste generated as a result of maintenance or structural repairs at no cost to PREPA if DOE has approved in advance the activity resulting in waste generation.

4.0 LTS&M Program

4.1 Radiological Surveys

PREPA will conduct quarterly and annual surveys to assess radiological conditions throughout the enclosed domed building in accordance with the procedures in the *Standard Operating Procedures Under Revision for the BONUS Reactor Facility* (PREPA 1998); *Sampling and Analysis Plan for the Boiling Nuclear Superheat (BONUS) Reactor Located in Rincón, Puerto Rico* (DOE 1999b); and the *Addendum to the Sampling and Analysis Plan for the BONUS Reactor* (Webb 2001). Quarterly and annual sampling will be performed at the locations identified in the *Standard Operating Procedures Under Revision for the BONUS Reactor Facility* (PREPA 1998), as modified by the addendum (Webb 2001). Both gamma radiation exposure rate monitoring and contamination level monitoring will be conducted. PREPA will submit an annual report of survey results to the DOE project manager for review and comment within 60 days of conducting the last survey of a calendar year. The report will include the results of radiological surveys conducted since the previous annual report. Annual reports will be available to the public and other agencies.

At its discretion, DOE will conduct independent radiological surveys of the facility or will accompany PREPA personnel during a regularly scheduled survey.

Gamma Radiation Exposure Rate Monitoring: Gamma radiation exposure rate measurements will be obtained to determine the gross radiation level associated with the entombment structure and the external piping system. In addition, five random measurements will be collected in areas permitted for public access. Additional measurements will be collected if any of the following conditions exist:

- The inspector observes excessive deterioration of the structures during visual inspection
- Any of the readings from the normal data collection points indicate a gamma radiation exposure rate in excess of 0.4 milliroentgen per hour (400 μR/h)
- The inspector observes any conditions that justify additional measurements

Gamma radiation exposure rate measurement data will be tabulated on data sheets that include the sampling locations, instrument identification (i.e., model and serial number), date of calibration, time of daily check, date of inspection, and inspector. If additional gamma radiation exposure rate measurements are collected, information such as (1) the reason for taking additional measurements, (2) the number and location of the measurements, and (3) observations and conclusions relative to the measurements, such as sampling conditions or procedures used, will be recorded.

Contamination Level Monitoring: Direct beta-gamma radiation measurements and smears will be taken in the same locations as the gamma radiation exposure rate measurements. Collection of these measurements is designed to determine gross contamination levels associated with the entombment structure and the external piping system. In addition, random sampling will include five large area swipes in five areas where public access is permitted. Additional total surface contamination smears will be taken if any of the following conditions exist:

- The inspector observes excessive deterioration of the structures during visual inspection
- Any of the measurements from the normal data collection points indicate a contamination level in excess of 1000 dpm (beta-gamma radiation)/100 cm^2 removable contamination or 5000 dpm (beta-gamma radiation)/100 cm^2 total surface contamination
- The inspector observes any conditions that justify additional measurements

Contamination smear and direct measurement data will be tabulated on data sheets that include the sampling locations, date of inspection, and inspector. If additional direct and smear measurements are taken, information such as (1) the reason for taking additional measurements, (2) the location of the contamination, and (3) observations and conclusions relative to taking the measurements, such as sampling conditions or procedures used, will be recorded.

4.2 General Inspection of the Facility by PREPA

PREPA will conduct quarterly visual inspections of the facility to evaluate the structural adequacy of the building, the general condition of the containment of both the entombment and the external systems, and the condition of areas open to public access. Inspection results will be summarized in a letter or memorandum addressed to the DOE project manager within 30 days of the inspection. The inspection will consist of the following:

Concrete Monolith Exterior: PREPA will conduct a visual inspection of the exterior concrete surfaces of the entombment structure. Inspectors will look for evidence of cracking that could

result in loss of structural or containment integrity or reduce the effectiveness of the concrete for shielding purposes. If PREPA inspectors observe cracking, PREPA will conduct gamma radiation exposure rate monitoring. If levels of radiation above acceptable criteria are found, PREPA will immediately restrict access and report the condition to the DOE project manager. The DOE project manager will then inform PREPA of the course of action to follow.

Concrete Monolith Penetrations: PREPA will visually examine entombment penetrations for evidence of cracking at weld joints or spalling of concrete. If PREPA observes degradation of penetration sealing systems, PREPA will conduct gamma radiation exposure rate monitoring. If levels of radiation are found above acceptable criteria, PREPA will immediately restrict access and report the condition to the DOE project manager. The DOE project manager will then inform PREPA of the course of action to follow.

External Piping Systems: PREPA will visually inspect external piping systems for corrosion, leaks, or integrity breaches. If PREPA finds visual indications of leakage or other failure, PREPA will conduct gamma radiation exposure rate monitoring. If levels of radiation are found above acceptable criteria, PREPA will immediately restrict access and report the condition to the DOE project manager. The DOE project manager will then inform PREPA of the course of action to follow.

Basement: PREPA will inspect the basement to determine whether water is present. If water is present, then PREPA will immediately inform the DOE project manager. PREPA and the DOE project manager will agree on the appropriate action, which will be in accordance with the RPP.

Main Floor: PREPA will inspect the main floor area to determine the condition and proper placement of access control barricades, ceramic floor tiles, and lead blocks.

Mezzanine: PREPA will inspect the condition and proper placement of access control barriers to the mezzanine level.

General Exterior Conditions: Inspectors should note changes within the 5-acre BONUS facility. Changes that might be significant include new development, changes in land use, and stability of hill slopes around the facility. Changes in land use and conditions beyond the 5-acre site should also be noted.

Special inspections will be made immediately following any unusual and potentially destructive events, such as extreme weather, earthquakes, or tidal waves.

Inspectors should use photographs, as necessary, to support or supplement written observations. Photographic documentation should include noting the location of the photograph on a map along with the azimuth. Photographs may be saved as digital files or prints and negatives.

4.3 General Inspection of the Facility by DOE

DOE will conduct independent inspections of the facility every 5 years and may choose to accompany PREPA personnel during a regularly scheduled PREPA inspection. DOE will contact PREPA and the mayor of Rincón (for public participation purposes) to inform them of impending visits.

4.3.1 Inspection Checklist

If DOE conducts an inspection, BONUS site leads will brief inspectors and the inspection checklist will be reviewed before the inspection. A sample inspection checklist is provided in Appendix C. The checklist includes:

- Specific site surveillance features to inspect.
- Routine observations to make.
- Special issues or problems to evaluate.

The checklist will be reviewed before and after the inspection and, if necessary, revised to reflect changes or new conditions at the site. The checklist will be accompanied by a copy of the *Office of Land and Site Management Project Safety Plan* (DOE 2004). This plan includes general and site-specific health and safety requirements for the inspection, including a list of local medical and emergency services.

4.3.2 Personnel

For a DOE inspection, typically a team of two or more inspectors will be assigned to conduct the inspection. Inspectors will be trained and experienced scientists, engineers, and radiological control technicians. The inspection team will be selected on the basis of skills and experience appropriate to the issues or concerns at the site. A radiological control technician must conduct the radiological surveys. If serious or unique conditions develop at the site, additional inspectors who are specialized in specific fields may be assigned to the inspection team.

4.3.3 Reporting

Inspectors shall report inspection results to key personnel from DOE and PREPA.

For DOE:
Project Manager
U.S. Department of Energy
Office of Legacy Management
Office of Site Operations
(636) 485-0036
Attention: Tiffany Drake (or successor)

For PREPA:
Acting Supervisor
Puerto Rico Electric Power Authority
Rincón, Puerto Rico
(787) 289-4989 or (787) 289-4988

The above persons or their successors and staff shall be referred to collectively as the BONUS Facility Joint Management Team ("Joint Management Team").

4.4 Follow-Up Inspections

Follow-up inspections may be conducted in response to significantly new or changed conditions at the site. DOE, PREPA, or both will conduct a follow-up inspection when:

- A condition is identified during a quarterly or annual inspection (or other site visit) that requires personnel, perhaps with special expertise, to return to the site to evaluate the condition.
- DOE or PREPA is notified by a citizen or outside agency that conditions at the site have substantially changed.

DOE or PREPA may request the assistance of local agencies to confirm the seriousness of a condition before conducting a follow-up inspection. Results of follow-up inspections will be described in a separate report that is submitted to the DOE project manager and PREPA supervisor within 30 days of the inspection.

4.5 Facility Maintenance

PREPA, as owner of the BONUS facility and its contents (except for the radioactive material), is responsible for maintaining the site in a safe and structurally sound condition for access by workers and the public and to maintain the integrity of the concrete monolith.

4.6 Emergency Response

A coordinated emergency response by the Joint Management Team may be required if unusual damage or disruption were to occur that could threaten or compromise site safety, security, or integrity. The information in Table 5 is a guide to the actions DOE and PREPA may take in response to a variety of potential problems.

Table 5. Criteria for Emergency Response

Priority	Event	Example	Response
1[a] (Urgent)	Extensive site damage	Earthquake or tidal wave causes damage to the enclosed domed building and flooding occurs	1. Notify Joint Management Team. 2. DOE/PREPA emergency response team conducts immediate follow-up inspection. 3. Determine level of radioactive release, if any. 4. Determine a course of action to repair facility.
2	Breach of site security with or without removal of radioactive materials	Willful human intrusion; significant vandalism	1. Notify Joint Management Team. 2. Assess damage. Perform risk assessment, if warranted. 3. Repair damage. 4. Evaluate current level of security. 5. Harden security, as necessary.
3	Erosion or instability of land surrounding the site	Erosion or deposition of sediments that affect the site, possibly after a hurricane or severe storm	1. Assess damage. Perform risk assessment, if warranted. 2. Repair damage, if necessary. 3. Stabilize eroded area, if necessary.

[a] Priority is highly dependent upon scale and onsite evaluation.

The table shows that the difference between various emergency responses is primarily one of risk or urgency. If a Priority 1 or 2 event occurs, an emergency response team will assess the damage and decide whether evaluation of the problem is required or if immediate intervention (corrective action) is essential. This decision will be based on the Joint Management Team's evaluation of the adequacy of the damaged feature to perform its intended function. To make this decision, the Joint Management Team will assess and evaluate the items listed below. The evaluation may include the following risk analysis:

- Adequacy of the design specifications for the damaged feature to control or accommodate the observed problems
- Extent of the damage, degradation, or departure from the design (or as-built condition) of the damaged feature
- Ability of the feature, in its damaged condition, to withstand a design-basis event

In the *Environmental Assessment for Authorizing the Puerto Rico Electric Power Authority (PREPA) to Allow Public Access to the Boiling Nuclear Superheat (BONUS) Reactor Building, Rincón, Puerto Rico* (DOE 2003a), an accident analysis was conducted for the enclosed domed building. Results of this analysis indicated that no radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios.

In 1969, a design-based accident analysis was generated by PRWRA and validated by the former AEC Division of Reactor Licensing for a severe earthquake and tidal wave scenario (DOE 2002). The earthquake was assumed to crack the enclosed domed building, the steel entombment liner, the concrete wall around the pressure vessel, the shield tank, the grout between the shield tank and the pressure vessel, and finally, the bottom of the pressure vessel. The enclosed domed building foundation was assumed to remain watertight and to be flooded to the level of the highest adjacent ground, about 2 feet (0.6 m) above the bottom of the pressure vessel. It was also assumed that the pressure vessel internals had been corroding at a conservatively high rate and that the corrosion products would be released instantaneously into the floodwater when the building was flooded. Ingestion and contact dose calculations indicated that the concentrations for nickel-63 did not exceed the maximum permissible body burden of 200 μCi for ingestion. On the basis of this information, the specifications for construction of the entombment system, and the most recent DOE inspection, the existing entombment would be capable of withstanding anticipated accidents.

A flood involving the basement area may occur during a major hurricane. Historical evidence indicates that the basement was flooded during Hurricane Georges in 1998 as a result of plugged storm water drains, defective door seals, and excessive runoff. Floodwater was allowed to evaporate from the area, and repairs were made to prevent recurrence.

In the event that a person such as an errant visitor gains access to the basement, the exposure rate, assuming an 8-hour stay, would be much less than a typical worker dose of 54 millirem per year (mrem/year). In addition, this dose would be far less than the primary dose limit of 100 mrem/year specified by DOE Order 458.1 Chg 4 for members of the public.

4.7 Records

LM maintains active records for the BONUS facility at the LM Business Center at Morgantown, West Virginia. Inactive records are stored at a Federal Records Center. Records contain information essential to the long-term care and custody of the site pursuant to applicable laws and regulations. Records include the BONUS facility decommissioning plan, radiological survey reports, Environmental Assessment, FONSI, annual Site Inspection reports, and other site-specific documents. Records in the DOE site collection addressing BONUS design, construction, operation, and decommissioning are duplicates of records managed by PREPA.

These records are available for agency and public inspection. Selected documents are available on the LM **Bonus Site** webpage at https://lmpublicsearch.lm.doe.gov/SitePages/default.aspx?sitename=BONUS.

Records for the BONUS facility are maintained in compliance with DOE requirements:

- DOE Order 200.1A Chg 1 (MinChg), *Information Technology Management*
- 36 CFR 1220−1236, "Records Management"

4.8 Public Participation

DOE seeks to encourage public participation in the surveillance and maintenance process at the BONUS facility site. DOE will accomplish this by:

- Disseminating site information, such as the LTS&M Plan and inspection results, through its website at https://www.energy.gov/lm/bonus-puerto-rico-decommissioned-reactor-site.
- Contacting the mayor of Rincón before making site visits.
- Responding to citizens' requests for information.

Through these activities, DOE hopes to ensure that the public and key community leaders are kept informed of site activities and status changes.

4.9 Quality Assurance

The long-term care of the BONUS facility and activities related to the annual surveillance, monitoring, and maintenance of the site comply with DOE Order 414.1D Chg 2, *Quality Assurance*, and *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ASQ 2004). Project-specific quality assurance requirements are detailed in the *Quality Assurance Program Plan for the Long-Term Surveillance and Maintenance Program* (DOE 2003d).

Quality assurance requirements are transmitted to subcontractors through procurement documents when appropriate.

4.10 Health and Safety

LTS&M activities are conducted in accordance with health and safety procedures established for the program. These procedures are consistent with DOE orders, regulations, codes,

and standards. The DOE Integrated Safety Management process serves as the basis for the contractor's Safety and Health program.

Specific guidance is contained in a job safety analysis (JSA) prepared for any field work performed at the BONUS Site. This JSA identifies specific hazards associated with the anticipated scope of work and provides direction for the control of these hazards. During the pre-inspection briefing, personnel are required to review the JSA to ensure that they understand the potential hazards and the safety and health requirements associated with the work to be performed.

5.0 References

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Appendix A

Letter of Agreement
Between the U.S. Department of Energy Office of Legacy Management and the Puerto Rico Electric Power Authority

COMMONWEALTH OF PUERTO RICO
Puerto Rico Electric Power Authority

Miguel A. Cordero López, P.E.
Executive Director

August 3, 2010

Mr. David W. Geiser
Director
Office of Legacy Management
Department of Energy
Washington, DC 20585

Dear Mr. Geiser:

A signed copy of the Letter Agreement is enclosed, which provides for monitoring and inspections support by PREPA, and public access with existing controls to the BOiling water NUclear Superheater (BONUS) reactor building as a museum attraction at Rincón, Puerto Rico.

We appreciate the support of the Department of Energy in PREPA's commitment to promote educational, cultural and historical benefits of the BONUS facility to all visitors of the museum.

Sincerely,

Enclosure

G.P.O. BOX 364267 SAN JUAN, PUERTO RICO 00936-4267 PHONE: (787) 521-4666 FAX: (787) 521-4665

Department of Energy
Washington, DC 20585

July 23, 2010

Miguel A. Cordero
Executive Director
Puerto Rico Electric Power Authority
Environmental Protection & Quality Assurance Division
Puerto Rico Electric Power Authority 7th Floor NEOS Building
1110 Ponce de León Ave. 704
Santurce, PR 00907

Dear Mr. Cordero:

For many years, the United States Department of Energy (DOE) and the Puerto Rico Electric Power Authority (PREPA) have worked on an agreement to give PREPA the documentation necessary for public access with existing controls to the BOiling water NUclear Superheater (BONUS) reactor building as a museum attraction at Rincon, Puerto Rico. Following meetings with PREPA in June 2008, LM continued discussions with Mr. Arsenio Reyes of your office and both parties believe that the attached draft Letter Agreement will provide the understanding necessary to move forward.

In 1972, the Atomic Energy Commission (AEC) terminated the operating authorization, the existing lease, and decommissioned the BONUS power station. LM and PREPA inspected the property in June 2008, and determined that all protective measures were complete. Thereafter, LM inspected and prepared for off-site shipment to the Idaho National Laboratory two remaining radioactive sources (i.e., detection units). LM and PREPA agree now that controlled public access for museum purposes is possible.

The attached Letter Agreement provides for monitoring and inspection support by PREPA and public access with existing controls for museum purposes that have been a long term goal of PREPA. Please review the attached letter agreement and, if agreeable, we can both sign it acknowledging our mutual understanding of the activities at the BONUS reactor building. Any questions may be directed to Mr. Steve Schiesswohl (720-377-9683 or Steve.Schiesswohl@LM.DOE.GOV), or Mr. Cliff Carpenter (304-413-0807 or Cliff.Carpenter@LM.DOE.GOV) of my staff.

Sincerely,

David W. Geiser
Director
Office of Legacy Management

3 Attachments

cc: Arsenio Reyes - PREPA
Steve Schiesswohl, LM-20
Tom Pauling, LM-20
Cliff Carpenter, LM-20
Jack Craig, LM-20
Steven Miller, GC-51
Michele Miller, Stoller

PREPA-DOE LETTER AGREEMENT

This Letter Agreement, between the U.S. Department of Energy (DOE) and the Puerto Rico Electric Power Authority (PREPA) establishes responsibilities and authorities, and provides for controlled public access to the BOiling water NUclear Superheater reactor building, hereinafter referred to as BONUS reactor building for the purposes of a museum.

BONUS Nuclear Power Facility consists of 132 acres owned by PREPA at Rincon, Puerto Rico. The BONUS Nuclear Power Facility (or the Facility) is located within a five-acre separately fenced area securing the reactor building, the theater and cafeteria, the training center building, the lockers and bathroom building, the administrative office building, and outside support structures. The BONUS reactor is an enclosed domed building that consists of three levels: the Reactor (Main) Level, the Mezzanine (Upper) Level, and the Basement (Lower) Level. Both the Reactor (Main) and Basement (Lower) Levels are available for controlled public access for the purposes of a museum.

Contract AT-(40-1)-4186 between the U.S. Atomic Energy Commission, (AEC), and the Puerto Rico Water Resources Authority (PRWRA, predecessor to PREPA), August 17, 1971, established the relationship and basis for the decommissioning of the BONUS reactor, and the post-decommissioning surveillance responsibilities of the radioactive materials contained therein. The BONUS Nuclear Power Facility was renamed on September 2, 2000, as Dr. Modesto Iriarte Technological Museum and in 2007 was listed under the National Register of Historic Places.

The BONUS reactor was decommissioned, all materials removed, and the reactor vessel was entombed in concrete as part of its final decommissioning in 1970. The AEC and its successor agency, DOE is represented by the Director of the Office of Legacy Management (LM) by Mr. David W. Geiser. The PREPA (formerly known as PRWRA), a public corporation and governmental instrumentality of the Commonwealth of Puerto Rico, created by Act of May 2, 1941, No. 83, as amended, is represented in this Letter Agreement by its Executive Director, Mr. Miguel A. Cordero.

DOE and PREPA have continued to monitor the BONUS reactor building and ensure safety measures are being maintained. In the last several years, PREPA developed a vision to document the historical aspects of the BONUS Nuclear Power Facility and its place in the history of the Atomic Age by collecting artifacts, equipment and documentation, and preparing exhibits to illustrate the development, construction, operation, and decommissioning of the BONUS reactor. As the BONUS reactor building had not previously been open to the public, this museum concept was evaluated by LM and PREPA to ensure public health and safety. It is very evident from the effort and dedication by the leadership and personnel of DOE and PREPA that the primary mission is public safety and the additional benefit of opening the BONUS reactor building to the public for its education and enjoyment.

On June 16, 2008, personnel of both DOE and PREPA inspected the BONUS reactor building and the associated remaining equipment and determined that physical and administrative controls were working and sufficient to protect the public if the facility was to be opened to the public. At that time, both DOE and PREPA believed that the BONUS reactor building was appropriate for public use as a museum and that PREPA could also assist DOE in inspections and reports.

The historical basis for LM's determination that public use was possible, under controlled conditions, is contained in the following three attached documents: 1) lease termination AEC letter (see Attachment A, AEC letter of February 10, 1972); 2) the letter terminating Operating Authorization DPRA-4 order in Docket 115-4 (see Attachment B, AEC letter of June 5, 1972); and 3) the AEC letter that clarifies the AEC intent that operations were terminated, nuclear fuel was removed and further indicating that the radioactive hazards were removed, mitigated and adequately controlled (see Attachment C, AEC letter of December 27, 1971).

PREPA is the owner of the BONUS Nuclear Power Facility and its structures and equipment, DOE remains responsible for the small amount of radioactive materials that remain inside the BONUS reactor building. All regulatory requirements have been satisfied and both DOE and PREPA understand their respective responsibilities and fully intend to work together in managing the BONUS reactor. DOE believes that public use of the BONUS reactor building for educational purposes should occur and DOE pledges to support PREPA in its use. In addition, DOE appreciates the unique ability of PREPA to manage the BONUS reactor building; promote the educational, historical, and cultural benefits of the entire BONUS Nuclear Power Facility; and provide special assistance to DOE by being available to inspect the BONUS reactor building and associated safety and protective measures and report to DOE any issues and concerns that DOE may need to address.

DOE appreciates the excellent efforts of the collection and preparation of the interpretive exhibits and documentation of the Atomic Age, its technology, and its people by PREPA and fully supports the controlled public use of the BONUS reactor building. Many benefits to DOE, PREPA, and the Puerto Rican citizens will be realized with the understanding embodied in this Letter Agreement. PREPA will continue to give DOE monitoring support and technical competence, in addition to inspections and frequent visual evaluations of the entombed reactor vessel. DOE will continue to meets is responsibilities of oversight and management of the radioactive materials entombed in the reactor vessel. The public and Puerto Rican citizens will gain one of the best examples of a demonstration reactor, complete with ancillary equipment and documentation that also includes historical and cultural interpretive exhibits and documentation of the colonization and development of Puerto Rico and its citizens.

By signing below, DOE and PREPA agree to the provisions of this Letter Agreement and agree that controlled public access is now allowable as of the date this Letter Agreement is executed by both DOE and PREPA.

For the U.S. Department of Energy:

7/22/10

Mr. David W. Geiser
Director
Office of Legacy Management

Date

For the Puerto Rico Electric Power Authority:

8/2/10

Mr. Miguel A. Cordero
Executive Director
Puerto Rico Electric Power Authority

Date

Appendix B

Finding of No Significant Impact (FONSI)

U.S. Department of Energy
Oak Ridge Operations, Oak Ridge, Tennessee

FINDING OF NO SIGNIFICANT IMPACT FOR AUTHORIZING THE PUERTO RICO ELECTRIC POWER AUTHORITY (PREPA) TO ALLOW PUBLIC ACCESS TO THE BOILING NUCLEAR SUPERHEAT (BONUS) REACTOR BUILDING, RINCÓN, PUERTO RICO

AGENCY: Department of Energy

ACTION: Finding of No Significant Impact

SUMMARY: The U.S. Department of Energy (DOE) has prepared an environmental assessment (EA), DOE/EA-1394, for authorizing the Puerto Rico Electric Power Authority (PREPA) to allow public access with existing controls to the Boiling Nuclear Superheat (BONUS) reactor building in Rincón, Puerto Rico. The BONUS was an experimental reactor constructed from 1960 to 1962 through the combined efforts of the Atomic Energy Commission (AEC, predecessor to DOE) and the Puerto Rico Water Resources Authority (PRWRA, predecessor to PREPA). The facility operated from 1962 to 1968, when it was shut down for economic reasons and the reactor was subsequently decommissioned. Decommissioning included: (1) removal of all special nuclear materials and certain highly activated components for disposal on the United States mainland, (2) in-place entombment of the pressure vessel and internal components within a three-story-tall concrete monolith within the dome-shaped reactor building, and (3) decontamination of contaminated systems located outside the entombed pressure vessel.

PREPA has proposed development of the BONUS reactor building as a museum that would be open to the general public, since this facility is one of only two reactors of this design ever built. Although the BONUS reactor building and associated equipment is owned by PREPA, DOE retains title to radioactive materials within the facility. Residual radioactive material is present in some areas of the reactor building, including the main level, which is the proposed site for the museum. Since DOE retains ownership for this material, DOE must ensure that the development of the proposed museum would not result in unacceptable radiation exposure of the public. The proposed action considered in the EA is limited to authorizing PREPA to allow public access to the proposed museum with existing controls. Radiological monitoring and surveillance would continue at the facility under the proposed action, although the potential for radiological exposure is considered to be low.

Based on the analyses in the EA, DOE has determined that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment, within the meaning of the *National Environmental Protection Act* of 1969 (NEPA), 42 U.S.C. Code § 4321, et seq. Therefore, the preparation of an environmental impact statement (EIS) is not required, and the Department is issuing this Finding of No Significant Impact (FONSI).

PUBLIC AVAILABILITY: Copies of the EA and FONSI are available from:

U.S. Department of Energy
Information Center
475 Oak Ridge Turnpike
Suite 300
Oak Ridge, Tennessee 37831
(865) 241-4780

For further information concerning the DOE NEPA process, contact:

David R. Allen, NEPA Compliance Officer
U.S. Department of Energy
Oak Ridge Operations Office
Post Office Box 2001, MS-SE-30-1
Oak Ridge, Tennessee 37831-8540
(865) 576-0411

PUBLIC PARTICIPATION:

The DOE Oak Ridge Operations Office issued an Environmental Assessment Determination (EAD) on March 29, 2001. In April 2001, DOE notified affected and interested stakeholders of its intention to authorize PREPA to allow public access to the BONUS reactor building in support of PREPA's proposal to develop a public museum at this facility. A public information meeting was held in Rincón, Puerto Rico on April 19, 2001.

The draft EA was distributed for public comment in August 2001, and the public comment period ended on October 17, 2001. Copies of the draft EA were distributed by mail to identified interested parties, and multiple copies were placed in the public library in Rincón.

A public notice of availability was published in the local newspapers announcing the availability of the draft EA for review. Public meetings were scheduled to be conducted on September 18, 19, and 20, 2001, in Rincón, but were canceled due to travel restrictions following the tragic events of September 11, 2001. Comments were received only from the U.S. Department of the Interior, Fish and Wildlife Service, regarding potential concerns about threatened and endangered species, and these comments have been addressed in the final EA.

DESCRIPTION OF PROPOSED ACTION:

Under the proposed action, DOE would authorize PREPA to allow public access to a museum to be developed within the BONUS reactor building. Under the proposed action, DOE would continue to provide radiological monitoring of the facility, including monitoring and surveillance of the concrete monolith within the BONUS reactor building, to ensure that no unacceptable radiation exposures occur. Public access would be allowed in the outer portion of the ring on the reactor floor. Public access to the basement and the other portions of the reactor-building

interior would be prohibited. Metal or plexiglass barricades and other physical barriers have been installed to prevent access to these areas, and these physical and administrative controls would be maintained under the proposed action. Residual radioactive materials exist in portions of the building where public access would be allowed, but are primarily fixed in place, and not removable and do not represent risk to the public, workers, or the environment.

ALTERNATIVES:

Two alternative to the proposed action were evaluated: (1) the no-action alternative (i.e., continued monitoring and surveillance of the BONUS facility without allowing public access), and (2) authorizing PREPA to allow public access to the BONUS reactor building for use as a museum only after additional decontamination to remove residual radioactivity above guidelines. Additional alternatives considered but not evaluated in detail included the removal and disposal of the concrete monolith, including shipment to an off-site disposal facility; and modification of the BONUS facility to enhance the structural stability of the reactor building and monolith structure.

No-Action Alternative

The no-action alternative is considered in accordance with the requirements of National Environmental Policy Act (NEPA) regulations (40 CFR 1500-1508), and provides a baseline against which the proposed action and other alternatives can be compared. Under this alternative, public access to the facility would not be allowed and the proposed development of a museum at this location would not proceed. Radiological monitoring and surveillance of the BONUS reactor facility by DOE would be continued.

Authorizing PREPA To Allow Public Access Following Additional Decontamination

Under this alternative, additional decontamination would be performed in those areas where elevated levels of residual radioactive materials remain above DOE guidelines, in order to further reduce radioactivity levels within the facility. Residual radioactivity above guidelines would be removed using standard decontamination techniques, such as scabbling of concrete surfaces, or additional shielding materials would be installed to reduce potential radiation exposures. The concrete monolith will remain inside the facility with residual radioactivity above DOE guidelines, and administrative and physical controls will maintain it as a restricted area to the public. Therefore, DOE would continue to be responsible for radiological monitoring and surveillance of the facility.

Following completion of the additional decontamination efforts, public access to a museum developed at the BONUS facility would be authorized. Public access would be allowed in the outer portion of the ring on the reactor floor and other specified areas of the building where residual radioactivity meets DOE guidelines; public access to the reactor monolith and any portions of the building containing residual radioactivity above DOE guidelines would be prohibited. Metal or plexiglass barricades and other physical barriers and administrative controls would be maintained to prevent access to these areas under this alternative.

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION:

The potential environmental impacts of the proposed action and alternatives were analyzed in the EA. All components of the proposed action were reviewed and appropriate agencies concerned with the protection of wildlife, threatened and endangered species, and cultural and historic resources were notified of the proposed action (authorizing PREPA to allow public access to the BONUS reactor building as a museum). Through the application of best management practices and with the implementation of appropriate mitigative measures, potential adverse environmental impacts to soils, water resources, and ecological resources would be expected to be minimal The FONSI for the proposed action is based on the following factors, which are supported, by information and analyses in the EA.

Demography and Socioeconomics

The proposed action would be expected to have positive socioeconomic impacts both in the short-term and long-term. Short-term impacts would include increased employment during the renovation of the BONUS facility and development of the proposed museum. Longer-term impacts would include employment of museum staff, guards and ancillary personnel, and also increased tourism revenues from museum visitors. No environmental justice concerns are associated with the proposed action, as there would be no high and adverse impacts, which would disproportionately impact any minority or low-income population.

Land Use

The proposed action would have no negative impacts on land use at the BONUS reactor site. The currently inactive BONUS facility would be operated as a museum for the public benefit. Surrounding land use would be unimpacted, except for the potential development of additional service businesses that might be developed in the vicinity to serve the increased tourist traffic.

Geology and Soils

No adverse impacts to geology and soils would result from the proposed action. The proposed action would take place within the existing reactor building and would result in renovation of the facility as a public museum.

Air Quality

Impacts to air quality would be negligible. There may be some increase in automobile traffic, both by construction workers during development of the museum facility and by visitors to the museum after its opening. However, any increase in traffic congestion and vehicle exhaust emissions would be expected to have negligible impact on local air quality.

Hydrology and Water Quality

No adverse impacts to hydrology and water quality would occur under the proposed action. The proposed action would take place within the existing reactor building and would involve no planned releases to surface water or groundwater.

Floodplains and Wetlands

No impacts to floodplains or wetlands have been identified under the proposed action. The BONUS site does not lie within the 100-year floodplain of any surface water body, and no wetlands have been identified at the site. All operations would be conducted within the existing BONUS reactor building.

Ecological Resources

No adverse impacts to ecological resources would be expected under the proposed action. All operations would be conducted within the existing BONUS reactor building.

The beaches adjacent to the BONUS facility provide potential nesting habitat for the endangered hawksbill sea turtle (*Eretmochelys imbricata*) and leatherback sea turtle (*Dermochelys coriacea*). In addition, the endangered plant *Buxus vahlii* is known to grow on the BONUS property. This site is one of five known locations on the island of Puerto Rico and it has one of the largest populations of this endangered plant. Since the scope of this DOE proposed action is limited to authorizing PREPA to allow public access to the proposed museum, the U.S. Department of Interior, Fish and Wildlife Service has concurred with DOE's determination that the proposed action is not expected to adversely impact any endangered species or its habitat.

Historical, Cultural and Archaeological Resources

No adverse impacts to historical, cultural or archeological resources would occur under the proposed action. All activities would take place within the existing BONUS reactor building. DOE discussions with the Advisory Council determined that no formal consultation with the State Historic Preservation Office would be required for the proposed action, and that the proposed action would be considered beneficial to the preservation of historical and cultural resources.

Noise

Noise impacts from the proposed action would be negligible. A minor, short-term increase in noise may be associated with renovation of the BONUS facility and construction of the proposed museum. Increases in vehicular traffic associated with the new museum would be expected to have a negligible impact on noise over the longer term.

Transportation

Transportation impacts associated with the proposed action would be minimal. There may be a minor increase in automobile traffic, both by construction workers during development of the museum facility and by visitors to the museum after its opening. However, no modification of roads or other infrastructure would be required to accommodate the additional traffic.

Human Health and Safety

No detrimental impacts to human health and safety would occur under the proposed action. Monitoring and surveillance of the renovated BONUS facility would continue to ensure that no radiation exposures in excess of applicable radiological protection standards would occur and that any physical or chemical hazards comply with applicable occupational, health and safety standards. Worker and visitor scenarios were studied and presented in the EA. Estimates of potential radiation dose to facility workers and the public are well below the limit of 100 mrem/year for members of the public set by DOE and the Nuclear Regulatory Commission. All radiation exposures would be reduced to levels as low as reasonably achievable (ALARA) in accordance with the PREPA radiation protection program for the BONUS facility. No unique occupational health and safety hazards would be associated with the proposed action; potential hazards, such as falls, spills, vehicle accidents, and injuries from tool and machinery operations, would be routine industrial hazards, which would be managed in accordance with OSHA requirements.

Accidents

Accident impacts associated with the proposed action would be minor. No radioactive or hazardous materials at the facility would be available for release under plausible accident scenarios. Accidents could occur during construction activities or operation of the new museum due to operator error, equipment malfunction, or from natural phenomena, but would be comparable to those at other industrial facilities and would be mitigated through appropriate safety procedures. Transportation accidents also could occur but would be expected to be similar to those that could occur under existing conditions at the BONUS site.

The site of the BONUS reactor building is susceptible to impact from hurricanes, and the basement area has been known to experience flooding during such events. Based on evaluation of the design basis accident, specifications of the reactor entombment system, and facility surveillance and monitoring, the existing entombment system is expected to be capable of withstanding anticipated hurricane, earthquake, and accident events.

Waste Management and Waste Minimization

The proposed action would have no impacts pertaining to waste management and waste minimization.

Cumulative Impacts

The proposed action would have minimal cumulative impacts on local or regional air quality, surface water and groundwater resources, existing habitats and biota, socioeconomics, transportation, and public and occupational health. Cumulative impacts would not be expected to increase appreciably over those that currently exist around the BONUS reactor site.

DETERMINATION:

Based on the analyses contained within the EA, DOE has determined that the proposed action to authorize the Puerto Rico Electric Power Authority (PREPA) to allow public access to the BONUS reactor building does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969. Therefore, an Environmental Impact Statement on the proposed action is not required.

Issued in Oak Ridge, Tennessee, this 24th day of February, 2003.

Gerald G. Boyd, Manager
Oak Ridge Operations Office

Appendix C

Inspection Checklist

Inspection Checklist
BONUS Decommissioned Reactor Facility, Rincón, Puerto Rico

Date of This Revision: _____

Last Inspection: _____

Inspectors: _____ and _____

Next Inspection (Planned): _____

No.	Item	Issue	Action
1	Specific site surveillance features	See attached table.	Inspect.
2	Enclosed domed building—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.
3	Enclosed domed building—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.
4	Enclosed domed building—basement	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.
5	Enclosed domed building—basement flooding	Water accumulating in basement may mobilize and redistribute surface contamination.	Inspect for gasket and storm water drains.
6	Enclosed domed building—main floor	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.
7	Enclosed domed building—mezzanine	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.
8	Enclosed domed building—exterior	Building should appear well maintained	Visually inspect.
9	Surrounding land	New or changing features or activities adjacent to the site may affect site security.	Note changes within 0.25 mile (402 m) of site.
10	General site upkeep	Building should appear well maintained.	Observe and evaluate changes in site conditions.
11	Site security	Security guard should be stationed at the 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.

Checklist of Site-Specific Surveillance Features
BONUS Decommissioned Reactor Facility, Rincón, Puerto Rico

Feature	Comment
Access road and parking area	Asphalt
Entrance gate	Motor-operated
Access through security gate	Note security of site; sign-in required on log sheet
Security fence	Chainlink, topped with three strands of barbed wire
Enclosed domed building—monolith plaques	Visually inspect