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United States Department of the Interior
National Park Service

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NAT. R

National Register of Historic Places Registration Form

1. Name of Property

historic name Boiling Nuclear Superheater (BONUS) Reactor Facility

other names/site number Museo Tecnológico BONUS Dr. Modesto Iriarte

2. Location

street & number Punta Higuero Sector, Road 413 (End) ☐ not for publication

city or town Rincón ☐ vicinity

state Puerto Rico code PR county Rincón code 117 zip code 00677

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended, I hereby certify that this X nomination ☐ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property X meets ☐ does not meet the National Register Criteria. I recommend that this property be considered significant ☐ nationally X statewide ☐ locally. (☐ See continuation sheet for additional comments.)

Aida Belen Rivera Ruiz — 14 September 2007
Signature of certifying official/Title — Date

Puerto Rico State Historic Preservation Office
State or Federal agency or Tribal government

In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. (☐ See continuation sheet for additional comments.)

Signature of certifying official/Title — Date

State or Federal agency and bureau

4. National Park Service Certification

I, hereby certify that this property is:

- ☒ entered in the National Register — 11/14/2007
  - ☐ See continuation sheet.
- ☐ determined eligible for the National Register
  - ☐ See continuation sheet.
- ☐ determined not eligible for the National Register
- ☐ removed from the National Register
- ☐ other (explain):

Signature of the Keeper — Date of Action

5. Classification

Ownership of Property

- ☐ private
- ☐ public-local
- X public-State
- ☐ public-Federal

Category of Property

- ☐ building(s)
- X district
- ☐ site
- ☐ structure
- ☐ object

Number of Resources within Property
(Do not include previously listed resources in the count.)

Contributing	Noncontributing	
6	0	buildings
0	0	sites
0	0	structures
0	0	objects
0	0	Total

Name of related multiple property listing

N/ A

Number of contributing resources previously listed in the National Register

N/A

6. Function or Use

Historic Functions
(Enter categories from instructions)
Industry: Energy Facility
Education: Research Facility

Current Functions
(Enter categories from instructions)
Recreation and Culture: Museum

7. Description

Architectural Classification
(Enter categories from instructions)

Other

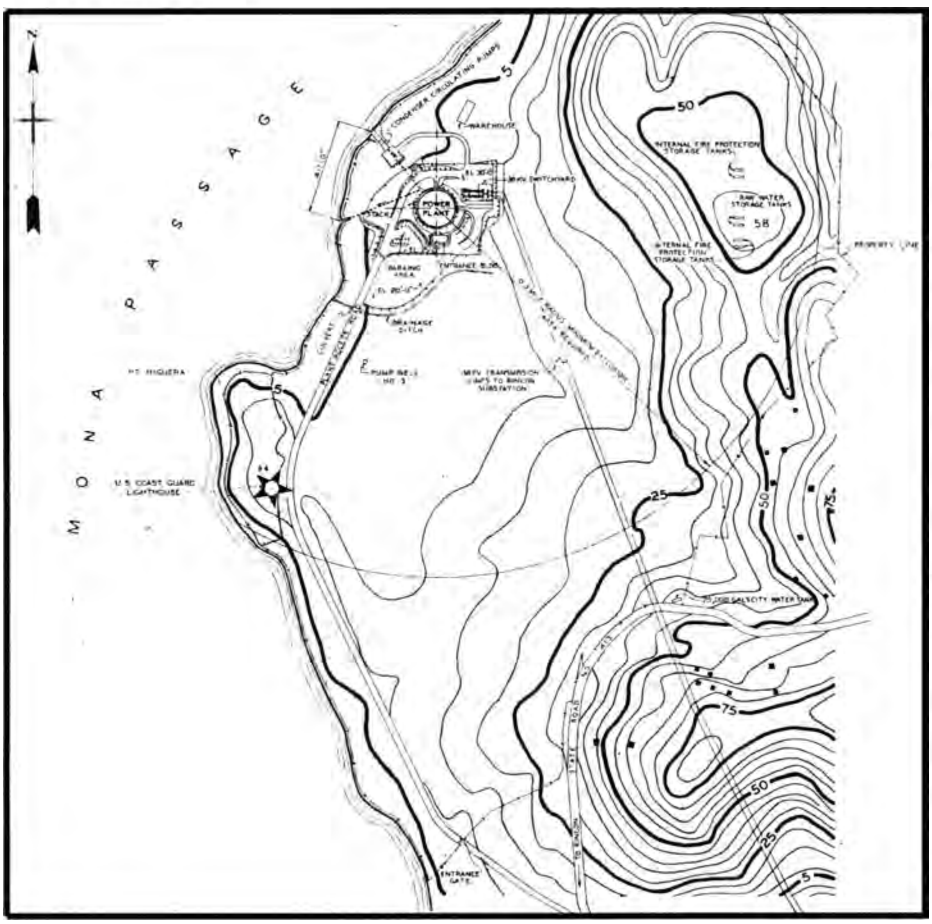
Materials
(Enter categories from instructions)

foundation concrete / steel
walls concrete / steel
roof concrete / steel
other

Narrative Description
(See Continuation Sheets)

NARRATIVE DESCRIPTION

Fig.1. Location of BONUS



The decommissioned **Boiling Nuclear Superheater (BONUS) Reactor Facility** is located on the westernmost coastal point (Punta Higuera) of Puerto Rico in the Municipality of Rincón (**Fig. 1**). The facility lies within a 5-acres (2 hectares) fenced area and is surrounded by 137 acres (55 hectares) of underdeveloped land primarily vegetated with brush, native pasture, and woodland. The access road to the site is 0.66 mile long, twenty six feet wide. It leads from State Road 413 through the Rincón Lighthouse parking lot and the facility entry gate, ending at the facility parking lot.[1] The entrance gate, near the guard shack, is twenty four feet wide and is motor-operated.[2]

[1] Rincón Lighthouse was included in the National Register of Historic Places on October 22, 1981.
[2] Originally, access to the entire 137 acres comprising the **BONUS** site was controlled at a guard shack located at the start of the paved, where it joins with Road 413. Access control was reduced to the 5-acre zone as a request from PREPA to the Department of Energy, so that the rest of the site could be used for future development. U.S. Department of Energy. Office of Legacy Management. *Long-Term Surveillance and Maintenance Plan for the BONUS Reactor Facility, Rincón, Puerto Rico*. May 2005, p. 2-3.

Figure 2. BONUS five-acre site.

A six foot high chain link fence, topped with three strands of barbed wired, encloses the 5-acre site (**Fig. 2**). Two parking lots, west and east of the entrance buildings, can accommodate 100 vehicles. They are constructed with crushed stone base and topped with a bituminous asphalt pavement. Within the fenced area, the landscaping consists of approximately 27,770 square feet of grass that is planted in the areas between the sidewalks, parking areas, and the Enclosed Domed building.

The **BONUS** facility includes six main buildings—the Enclosed Domed Building, Entrance Building (consisting of the bathrooms and lockers area and the administrative offices, connected by a breezeway), Auditorium (also known as the theater) Training Center and a guard shack.

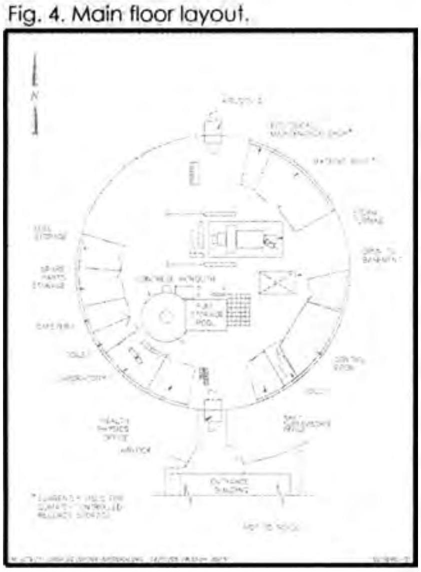
Fig. 3. The Domed Building

The Enclosed Domed Building is definitely the most impressive landmark within the complex (**Fig. 3**)[3]. The 160-foot diameter steel building, with an outer concrete cover, was designed to withstand earthquakes, up to 200 miles hurricane winds, and an internal pressure of up to 720 pounds per square foot. It consists of three levels: basement, main floor, and mezzanine. North and south entrances provide access to the main floor and are equipped with a system of air lock chambers between two steel security doors. All doors are currently operational. The basement is directly below the main floor and is posted as a radiological controlled area. The two stairways to this level are posted and barricaded with expanded metal. A barricade of Plexiglas and expanded metal on a steel handrail surrounds the area that is open to the main floor for moving fuel from transport trucks to the fuel

[3] According to PREPA's engineers, containment of any substance is a lot easier in a dome structure.

storage facility. Another entrance is located at the basement; originally used for fuel handling, this entrance is now sealed.

Fig. 4. Main floor layout.



On the center of the main floor is the turbine, the access to the basement for fuel handling, and the crane tower (**Fig. 4**). The concrete monolith, which contains the reactor pressure vessel, rises through the main floor from the basement to the mezzanine level. Barricades constructed of Plexiglas panels mounted on steel hand railing surround the center area and restrict public access due to fixed contamination. These barricades could be easily removed in the future (once the half-life of the radioactive material is reached) and, as designed, do not affect the perception of the space. The main floor has been developed into a museum (**Fig 5**). 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 the Puerto Rico Electric Power Authority (PREPA), Nobel Prize winners, scientists, the solar system, and space travel is discussed and pictured in panels. A computer learning room with 12 computers stations has been set-up in what used to be the Health Physics Office.

Fig. 5. Views of the turbine, crane tower and the concrete monolith and the museum displays on the main floor.

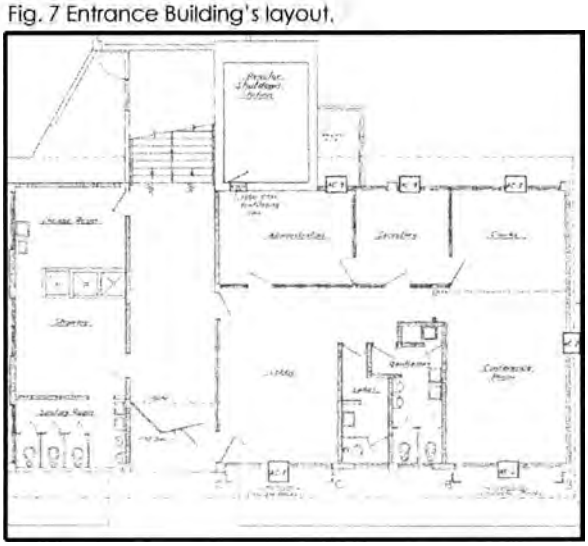
United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

The reactor control room is still intact and, although it is inactive, control lights have been wired to display an operational effect (**Fig. 6**). The mezzanine is located above the main floor and provides access to the top of what used to be the reactor, which is now a solid concrete monolith. For security reasons, access to the mezzanine level is restricted.

Figure 6. Control Room

Fig. 7 Entrance Building's layout.



The Entrance Building is located on the south end of the Enclosed Domed and may be accessed directly from the parking lot. It's composed of three sections: the bathrooms, the lockers room area and the administrative offices, separated by a covered breezeway. The administrative area contained offices, restrooms, and a conference room. During plant operations, it also contained an auxiliary Control Room or Reactor Shutdown Station (**Fig. 7**).

Fig. 8. From left, Auditorium and Training Center Buildings.

The Auditorium Building is located west of the Enclosed Domed Building. It's primarily used for training and meetings of PREPA personnel, as well as rented to the general public. During plant operations it contained a cafeteria and an open-air dinning area. The Training Center is a concrete building located north of the auditorium (**Fig. 8**). It was used as office space and dormitories for visiting scientists when **BONUS** was in operation. PREPA has no immediate plans for this building but a history museum is being considered for this structure.

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing)

X A Property is associated with events that have made a significant contribution to the broad patterns of our history.

☐ B Property is associated with the lives of persons significant in our past.

X C Property embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

☐ D Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark "X" in all the boxes that apply.)

Property is:

☐ A owned by a religious institution or used for religious purposes.

☐ B removed from its original location.

☐ C a birthplace or a grave.

☐ D a cemetery.

☐ E a reconstructed building, object, or structure.

☐ F a commemorative property.

X G less than 50 years of age or achieved significance within the past 50 years.

Areas of Significance
(See Continuation Sheets)

<u>Social History</u>
<u>Industry</u>
<u>Engineering</u>

Period of Significance

1963- 1968

Significant Dates

1964

Significant Person

N / A

Cultural Affiliation

N / A

Architect/Builder

N / A

Narrative Statement of Significance
(See Continuation Sheets)

NARRATIVE STATEMENT OF SIGNIFICANCE

The **Boiling Nuclear Superheater (BONUS) Reactor Facility** is significant statewide under Criterion A because the property is associated with the broad national policies established during the presidency of Dwight David Eisenhower in the program "Atoms for Peace" and John F. Kennedy and Lyndon B. Johnson's "Alliance for Progress." **BONUS** is also significant under Criterion C in the field of Engineering as a pioneer in the technology and process of managing material and equipment to produce electricity through nuclear fission at an early stage of this crucial industry.[4] **BONUS** served as an experimental facility. The decommissioned reactor was developed as a prototype nuclear power plant to investigate the technical and economic feasibility of the integral boiling-superheating concept. This small scale nuclear reactor produced saturated steam in the central portion of the reactor core, superheated it in four surrounding sections of the core and then used the steam in a direct loop to drive a turbine generator. **BONUS** was one of only two boiling-water superheater reactors ever developed in the United States and the first to be built outside the mainland. It became the first nuclear plant built in Latin America. The knowledge derived from **BONUS** was applied to the eventual development of many other nuclear plants.

HISTORICAL BACKGROUND AND SIGNIFICANCE

Rapid strides in nuclear weapons technology had begun at the end of World War II. In 1945, the two atomic bombs dropped on Japan had killed an estimated 106,000 people and had injured approximately 110,000 others. The larger of the two, the Nagasaki bomb, had released the explosive equivalent of 23,000 tons of TNT. In 1948, the United States tested even larger atomic bombs in the Pacific, and by 1949, with the detonation of a nuclear device, the Soviet Union achieved its own nuclear capability. In response to the Soviet atomic bomb program, the United States embarked upon a race to develop an even larger weapon: the hydrogen bomb, which promised explosive power in the range of millions of tons of TNT. The United States successfully detonated a hydrogen device in November 1952; just a few days after Dwight David Eisenhower won the Presidency. With it, the United States and the world entered the thermonuclear age.

[4] In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use nuclear fission to produce electricity.

The escalating nuclear arms race between the United States and the Soviet Union, which included the development of thermonuclear bombs, brought Eisenhower to the United Nations. In his "Atoms for Peace" speech before the United Nations on December 8, 1953, Eisenhower sought to solve this terrible problem by suggesting a means to transform the atom from a scourge into a benefit for mankind. The "Atoms for Peace" speech reflected his deep concern about "Atoms for War." President Dwight D. Eisenhower was determined to solve "*the fearful atomic dilemma*" by finding some way by which "*the miraculous inventiveness of man would not be dedicated to his death, but consecrated to his life*." [5] Although not as well known as his warning about the "military industrial complex," voiced later in his farewell radio and television address to the American people, Eisenhower's Atoms for Peace speech embodied his most important nuclear initiative as President. From it sprang a panoply of peaceful atomic programs. On August 30 1954, President Eisenhower signed the Atomic Energy Act of 1954, the first major amendment of the original Atomic Energy Act, giving the civilian nuclear power program further access to nuclear technology. The original Atomic Energy Act was signed on August 1, 1946. It created the Atomic Energy Commission (AEC) to control nuclear energy development and explore peaceful uses of nuclear energy. On January 10, 1955, the AEC announced the "Power Demonstration Reactor Program." Under this program, the AEC and the private industry would cooperate in constructing and operating nuclear power reactors.[6] The eventual construction of **BONUS** responded precisely to this crucial historical moment (**Fig. 9**).

Fig. 9 Luis Muñoz Marín(with the shovel) at construction ceremony, 1960.

Although the construction of **BONUS** didn't take place until the first years of the 1960s, the exchange of ideas among the local political leaders and the Atomic Energy Commission were underway since mid 1950s. This is clearly expressed in a letter sent by Governor Luis Muñoz Marín to Admiral Paul F. Foster, Assistant General Manager for International Activities of the AEC:

"The Commonwealth of Puerto Rico is vitally interested in atomic energy. We need continuously and intelligently to appraise the values for Puerto Rico of the proliferating series of applications of atomic energy in agriculture, in health, in

[5] Address given by Dwight D. Eisenhower before the General Assembly of the United Nations on Peaceful Uses of Atomic Energy, New York City, December 8, 1953. Dwight D. Eisenhower Presidential Library, Milestone Documents Section.
[6] In 1957, the first power from a civilian nuclear unit was generated by the Sodium Reactor Experiment at Santa Susana, California.

> industry and in power. It is proposed that consideration be given by the Commission to the early establishment in Puerto Rico of a nuclear reactor and electric power generating station, which will serve as a source of electrical energy to be integrated with the power system of the Water Resources Authority." [7]

In the same document Governor Muñoz proposed:

> "...that such a nuclear power plant would be and remain the property of the AEC, constituting a research and development facility under the Commission's own program. The Commonwealth would contribute to the costs of these facilities thru payment of the expenses of their operation and maintenance, provision of land and utility service facilities, and thru purchase of the electrical output by the Water Resources Authority at a price agreed upon with the Commission."[8]

These comments are the foundation of the theoretical functionality of **BONUS.** The first public announcement done by the local government and the AEC about **BONUS** came out on January 1960.[9] Besides the local newspapers, the contract signed by the Puerto Rico Water Resources Authority (PRWRA) and the AEC was advertised through *Voice of America*, reflecting the importance of the event to Latin America.[10]

Two locations were mentioned as possible sites for the nuclear plant: Punta Jaguey in the municipality of Cabo Rojo and Punta Higuera in the municipality of Rincón. Punta Higuera was finally chosen for various reasons: a) Being the westernmost coastal point of Puerto Rico and considering the usual prevailing winds coming from the east, it was sound safe to believe that any radiation leak will blow into the ocean; b) the closeness of the site to the University of Puerto Rico, Mayaguez Campus, and its highly scientific oriented staff; c) the proximity to an already established 38,000 volts power line running through the area; d) the proximity to State Road # 2; and e) a natural incline of the terrain toward the ocean that would it kept any superficial leak away from the inhabitable areas.

[7] Archivo General de Puerto Rico. Fondo: Gobernador. Expediente sobre Energía Atómica. Letter dated September 18, 1956. The documentation shows constant exchanges of ideas, comments and questions among Governor Luis Muñoz Marín, the Puerto Rico Water Resources Authority (today Puerto Rico Electric Power Authority) and personnel from the AEC (today Department of Energy) since 1955.
[8] Ibid.
[9] Newspaper El Mundo. January 13, 1960. pp. 1
[10] Voice of America is a US sponsored radio station, established during the 1940s, originally used to transmit news programs to Europe and North Africa. It was later extended to cover the Latin American countries.

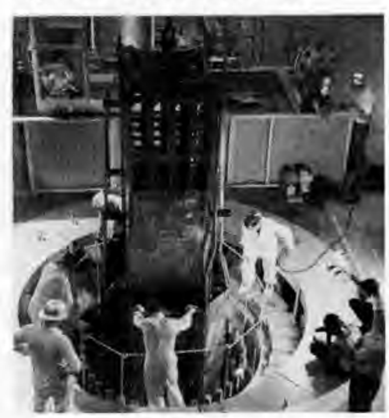
BONUS Site

Fig. 10 BONUS, June 1962.

The facility was comprised within a five-acre fenced area compound (**Fig. 10**). The site was surrounded by 137 acres of undeveloped land that served primarily as a buffer zone when the plant went into operation. The project had a total cost of $16,150,000. The AEC provided the amount of $12,400,000. The balance was provided by PRWRA in terms of equipment and real estate value.

The construction of the buildings on the site was subcontracted to the Maxon Construction Company and Chicago Bridge Construction Company. The last one was responsible for the design and construction of the Domed Building.[11] Construction of the reactor began in 1960 through a combined effort of the Atomic Energy Commission and Puerto Rico Water Resources Authority. Following the guidelines of the "Power Demonstration Reactor Program" the construction and design of the reactor was assigned to a private company, General Nuclear Engineering Corporation from Dunedin, Florida.

Fig. 11. BONUS reactor, 1963.



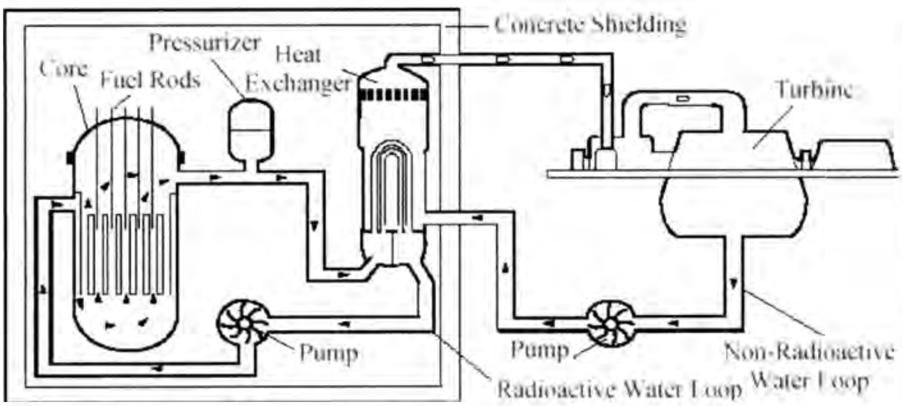
The reactor was developed as a prototype nuclear power plant to investigate the technical and economic feasibility of the integral boiling-superheating concept. The reactor first achieved a controlled nuclear chain reaction on April 13, 1964, being the first time that electricity was produced in Latin America through nuclear fission (**Fig. 11**). **BONUS** then underwent a series of criticality tests, operating experimentally at various power levels, first as a boiler and later as an integral boiler-superheater. Operation at full power (50 megawatts of thermal energy) and full temperature (900° Fahrenheit) was achieved in September 1965, and test demonstrated satisfactory operation at 10 percent over power in November 1965. All electricity produced at

[11] Newspaper El Mundo. February 20, 1960. pp. 19.

BONUS, from 1964 until 1968, was relayed to the Mayaguez Power Station.

Today, there are two types of nuclear power plants used in the United States: boiling water reactors (BWRs) and pressurized water reactors (PWRs). **BONUS** was a prototype of a BWR power plant. 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 x 6 square array with the 4 central rods omitted. The superheating portion of the reactor consisted of four rectangular section, 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 Megawatts (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, **BONUS** was able to heat the steam to 900° Fahrenheit.

Fig. 12. Diagram of a power plant reactor.



Most power plants burn fuel to produce electricity, but not nuclear power plants. Instead, nuclear plants, like **BONUS,** use the heat given off during fission as fuel. Fission takes place inside the reactor (**Fig. 12**). At the center of the reactor is the core, which contains the uranium fuel. The uranium fuel is formed into ceramic pellets. The pellets are about the size of the fingertips, but each one produces the same amount of energy as 150 gallons of oil. These energy-rich pellets are stacked end-to-end in 12-foot metal fuel rods. A bundle of fuel rods is called a fuel assembly. Fission generates heat in a reactor just as coal generates heat in a boiler. The heat is used to boil water into steam.[12] The steam is channeled to turn huge turbine blades. As they turn, they drive generators that produce electricity. Afterward, the steam is changed back into water and cooled in a separate structure (condenser). The water can be used again and again.

[12] The water used at **BONUS** was ocean water taken through an underground intake chamber. See Section 10, Site Layout.

But **BONUS** was a lot more than just a prototype nuclear reactor to produce electricity. Very important political ties were also produced at **BONUS**. At the time of its construction, the social and economic policies of Operation Bootstrap were in fast motion. The local government representatives were involved in breaking the island's dependency on the agricultural production by rapidly re-orienting the economy toward the light and heavy industry. A huge campaign was launched to "sell" Puerto Rico as a safe heaven for Americans and international investors. The creation of the showcase image of an Island immersed in the new high-speed technology was an essential part of Operation Bootstrap. The establishment of **BONUS** fitted perfectly within the local social and political project.

The plant fitted perfectly also within the US national program promoted by John F. Kennedy's "Alliance for Progress." The Alliance for Progress, begun in 1961, was a US assistance program for Latin America. It was created, principally, to counter the appeal of revolutionary politics, such as those adopted in Cuba. It called for vast multilateral programs to relieve the continent's poverty and social inequities providing US economic and military programs to counter Communist influence. The charter of the alliance, formulated at an inter-American conference at Punta del Este, Uruguay, in August 1961, called for an increase in the per capita income, the establishment of democratic governments, more equitable income distribution, land reform, and economic and social planning.[13]

In an address given at a White House reception for Latin American diplomats and members of Congress on March 13, 1961, President Kennedy expressed that:

> "All the people of the hemisphere must be allowed to share in the expanding wonders of science-wonders which have captured man's imagination. I invite Latin American scientists to work with us in new projects in fields such as medicine and agriculture, physics and astronomy and desalination, and to help plan for regional research laboratories in these and other fields, and to strengthen cooperation between American universities and laboratories...We must rapidly expand the training of those needed to man the economies of rapidly developing countries..." [14]

[13] Avalon Project. Yale Law School. The Charter of Punta del Este, establishing an Alliance for Progress within the framework of Operation Pan America, August 17, 1961.
[14] Department of State Bulletin, XLIV, No. 1136 (April 3, 1961), pp. 471-474.

BONUS embodied these presidential policies. Through its operational life, the facility became a training camp for hundreds of Latin American scientists who got their first contact with the new nuclear technology at the site. Its physical closeness, cultural proximity and the common language made **BONUS** an exemplary promoter and a successful bridge of the political and social projects envisioned in Kennedy's "Alliance for Progress." [15]

By 1968, the AEC considered that **BONUS** had accomplished its original purposes. The experiences and knowledge acquired at **BONUS** were extremely useful and applied into larger and most cost efficient nuclear plants in the United States.[16] To make the electricity produced at **BONUS** competitive with thermoelectric plants would it require an increased in its power capabilities. Considering the easy access to cheap oil at the time and the ensuing need for high-cost modifications, PREPA decided that it was not economically productive to keep the facility in active status. Operation of the **BONUS** reactor was terminated in June 1968. The Puerto Rico Water Resources Authority decommissioned the reactor between 1969 and 1970. During decommission all special nuclear material (fuel) and certain highly activated components (control rods and shims) were removed and sent to the Office of Environmental Management at Oak Ridge, Tennessee. 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 iron room, beneath the pressure vessel, and entombed in concrete. A stainless steel time capsule, containing decommissioned documents and drawings, was placed in the concrete monolith for future recovery.[17]

[15] Approximately 694 scientists and students (from 41 foreign countries) received training at **BONUS**. Justo E. Varela Dieppa. *Breve historia del desarrollo de la energía nuclear en Puerto Rico, 1957 – 1981*. Center for Energy and Environment Research. University of Puerto Rico – US Department of Energy. September 1981.
[16] Nuclear power accounts for about 19% of the total net electricity generated in the US, about as much as the electricity used in California, Texas and New York, the three states with the most people. In 2005, there were 66 nuclear power plants (composed of 104 licensed nuclear reactors) throughout the United States. Department of Energy. Statistics Section.
[17] The time capsule is schedule to be open in 2045. US Department of Energy. Office of Legacy Management. *Long-term surveillance and maintenance plan*...pp. 2-11.

Fig. 13. Dr. Modesto Iriarte (right) at BONUS, 1963.

Today, the facility serves as a museum and has been renamed *Museo Tecnológico BONUS Dr. Modesto Iriarte* **(Fig. 13)**.[18] The physical structures have a huge level of integrity, especially the Domed Building. Everything within the interior appearance has been worked to give the feeling that you are entering into an operational nuclear plant.

BONUS represents a historically significant period. A prototype nuclear reactor, one of only two of its kind in the world, the first nuclear power plant built by the US outside the main-land, the first nuclear plant to operate in Latin America and the embodiment of vital presidential national policies. All these characteristics make **BONUS** a very special and significant property.

[18] Dr. Modesto Iriarte was born in 1923 in Mayaguez, Puerto Rico. At the age of 21, he graduated from the University of Puerto Rico as an Electrical Engineer. Upon graduation he joined the faculty of the Electric Engineering Department of the UPR Mayaguez Campus. Subsequently, Iriarte earned a Master's Degree in Electrical Engineering from Texas A&M University. In 1951, he obtained a second Bachelors Degree in Civil Engineering. In 1955 he began studies in the International School of Science and Nuclear Engineering located in the Laboratories of the Atomic Energy Commission in Argonne, Chicago. The school accepted only specially qualified students recommended by the governments of the respective countries. Iriarte became a pioneer in the nuclear field, since this school was unique, opening its doors in 1955 for the first time. He focused his studies on the boiling water reactors. By 1956, Iriarte attended the University of Michigan to pursue doctoral studies in Nuclear Engineering. He completed the program in two years, graduating in June 1958. He was one of the first students in the United States to earn a Ph.D. in Nuclear Engineering, and the first from Puerto Rico. He was deeply involved in the development, design, construction and operation of the reactor established at BONUS. After BONUS was decommissioned, Iriarte attended the University of California, where he successfully completed the Course of Engineering Management. From 1965 until 1975, Iriarte was in charge of developing and expanding PREPA's generation and transmission system. Upon retirement he continued to work with the Puerto Rico Electric Power Authority for $ 1 a year. Between 1985 and 1993 he was PREPA's Governing Board President. Today, Dr. Iriarte continues to participate as an active member of the Governing Board and collaborates with its many committees.

9. Major Bibliographical References

Bibliography
(See continuation sheets)

Previous documentation on file (NPS):

- ☐ preliminary determination of individual listing (36 CFR 67) has been requested.
- ☐ previously listed in the National Register
- ☐ previously determined eligible by the National Register
- ☐ designated a National Historic Landmark
- ☐ recorded by Historic American Buildings Survey # ______________
- ☐ recorded by Historic American Engineering Record # ______________

Primary Location of Additional Data:

- ☐ State Historic Preservation Office
- ☐ Other State agency
- ☐ Federal agency
- ☐ Local government
- ☐ University
- X Other

Name of repository: Puerto Rico Electric Power Authority

10. Geographical Data

Acreage of Property 5-acre

UTM References
(Place additional UTM references on a continuation sheet)

	Zone	Easting	Northing
1.	19	682925.39	2031463.22

Verbal Boundary Description
The property is historically associated with the lot register at the Puerto Rico Register of Property: 095-000-004-03

Boundary Justification
See continuation sheets.

MAJOR BIBLIOGRAPHICAL REFERENCES

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NPS Form 10-900-a
(8-86)

OMB No. 1024-0018
(Expires 1-31-2009)

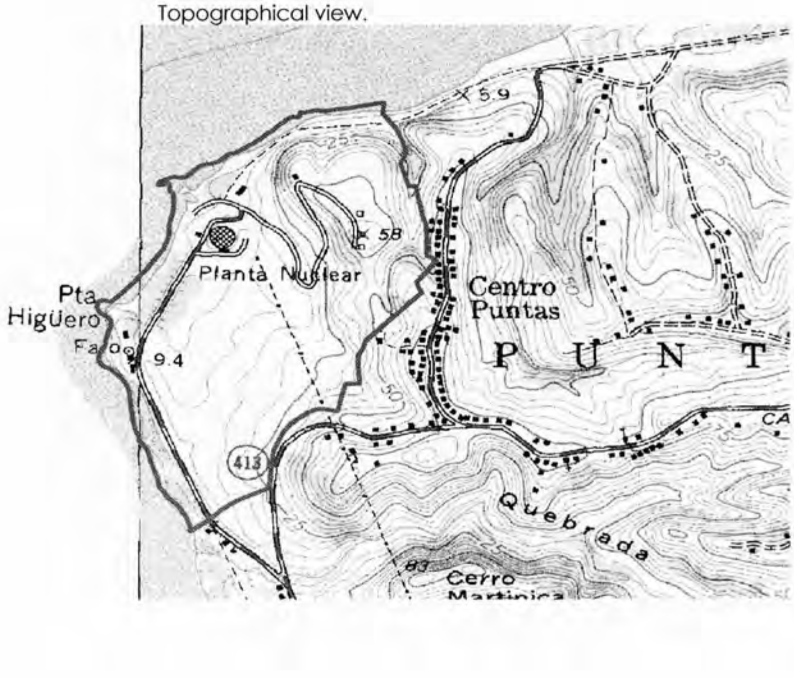
United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES CONTINUATION SHEET

Geographical Data

Aerial view of the 137-acre lot.

Topographical view.



11. Form Prepared By

name/title Juan Llanes Santos/ State Historic Preservation Office

organization Puerto Rico State Historic Preservation Office date September 6, 2007

street & number PO Box 9066581 telephone 787-721-3737

city or town San Juan state PR zip code 00906-6581

Additional Documentation

Submit the following items with the completed form:

Continuation Sheets

Maps

A **USGS map** (7.5 or 15 minute series) indicating the property's location.

A **sketch map** for historic districts and properties having large acreage or numerous resources.

Photographs

Representative **black and white photographs** of the property.

Additional items
(Check with the SHPO or FPO for any additional items)

Property Owner

name Puerto Rico Electric Power Authority

street & number 1110 Ponce de León Avenue telephone 787-289-4666

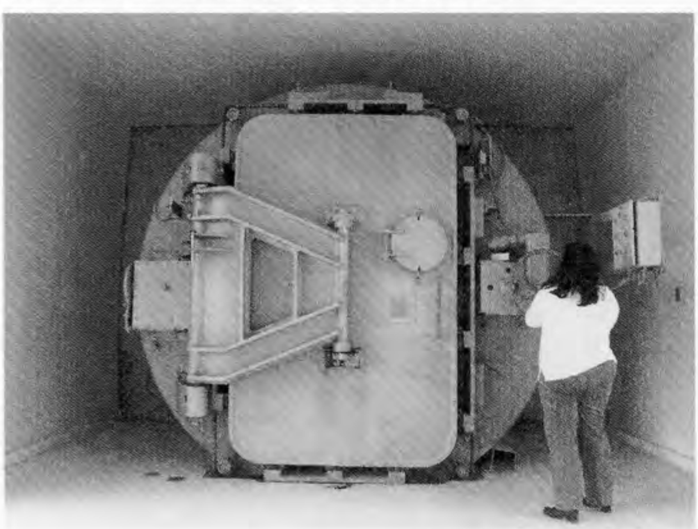
city or town Santurce state PR zip code 00936

Partial Views

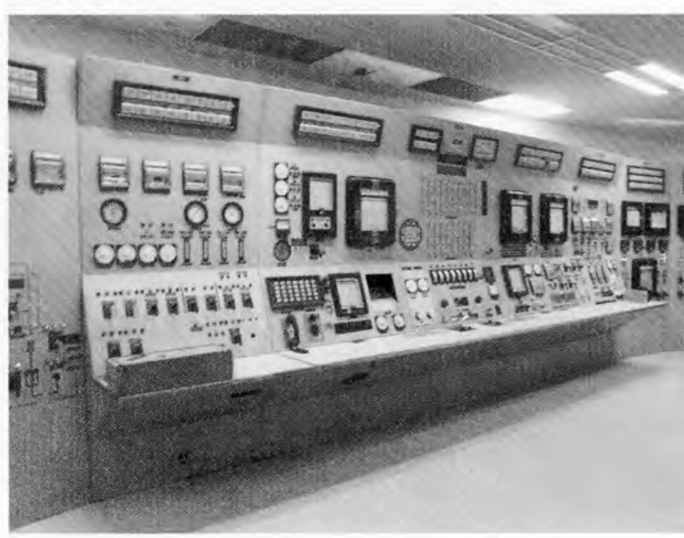
Aerial view of five-acre site.

Domed Building north entrance.

Main entrance to Domed Building, airlock chamber 1.



Control room.



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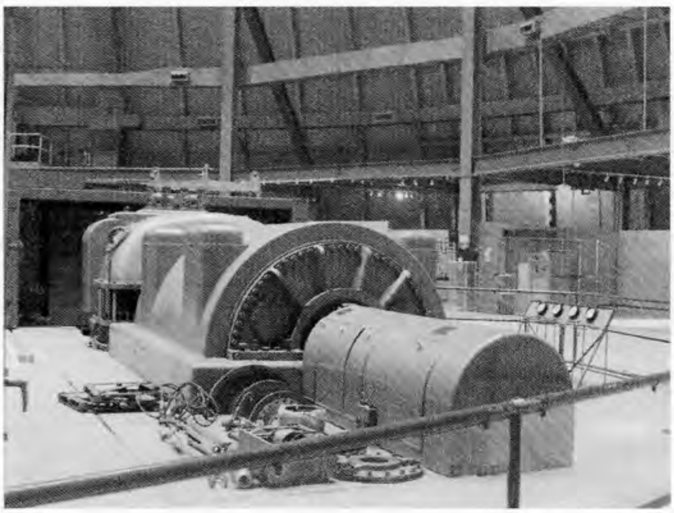
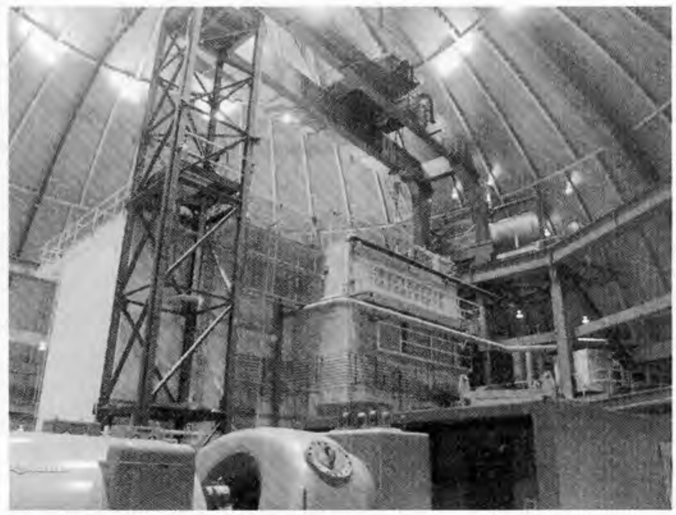
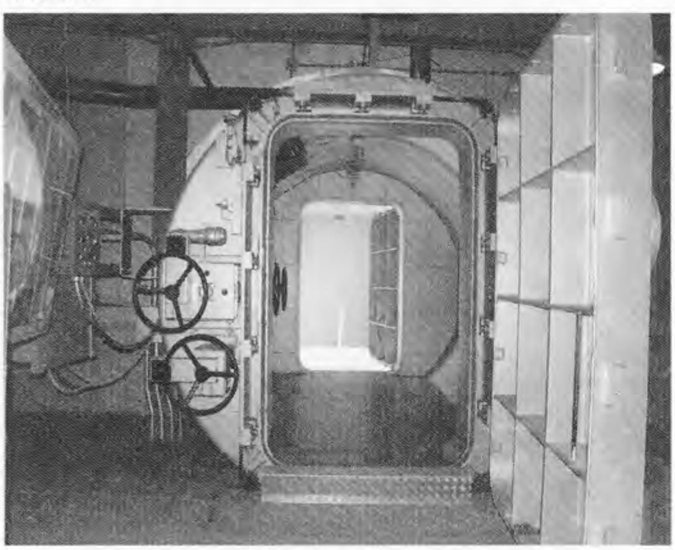
Generator and steam turbine.



Main crane.



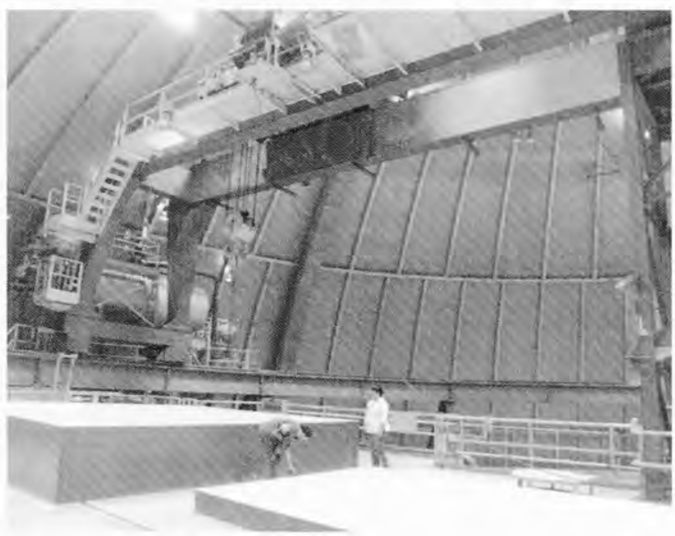
Airlock 1.



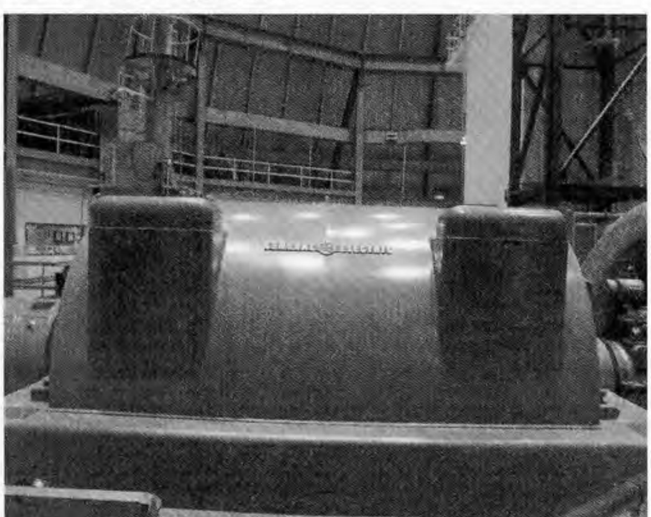
Top of concrete monolith.

Steel rail frame

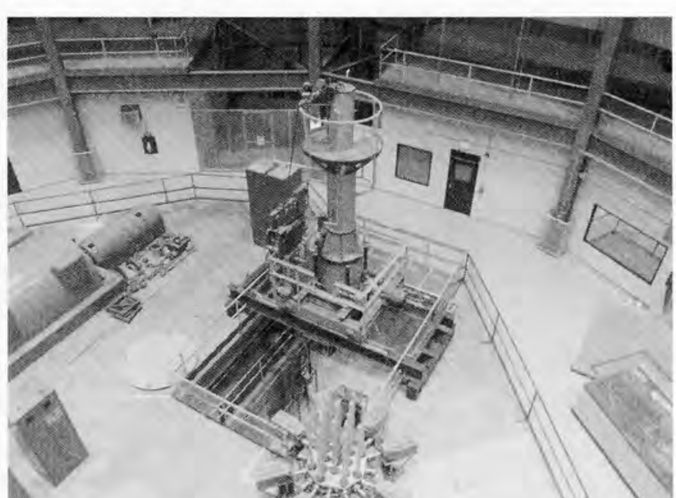
Main crane and top of concrete monolith.



General Electric generator.



Covered fuel storage pool.



United States Department of the Interior
National Park Service

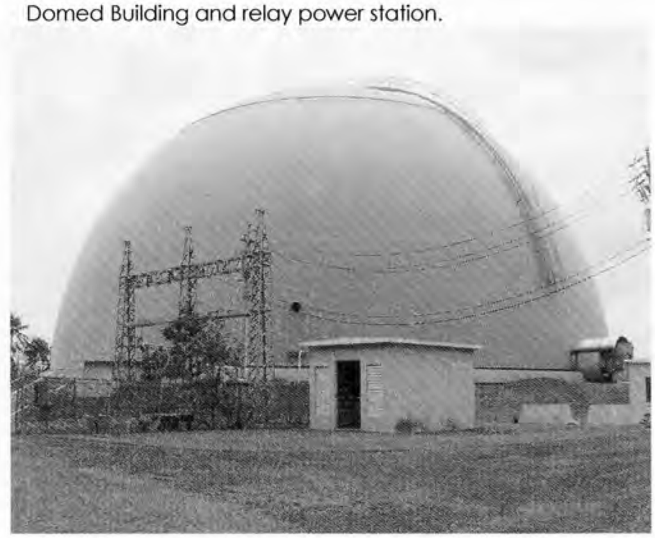
NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Entrance Building

Entrance Building, west wing.

Airlock 2

Domed Building and relay power station.



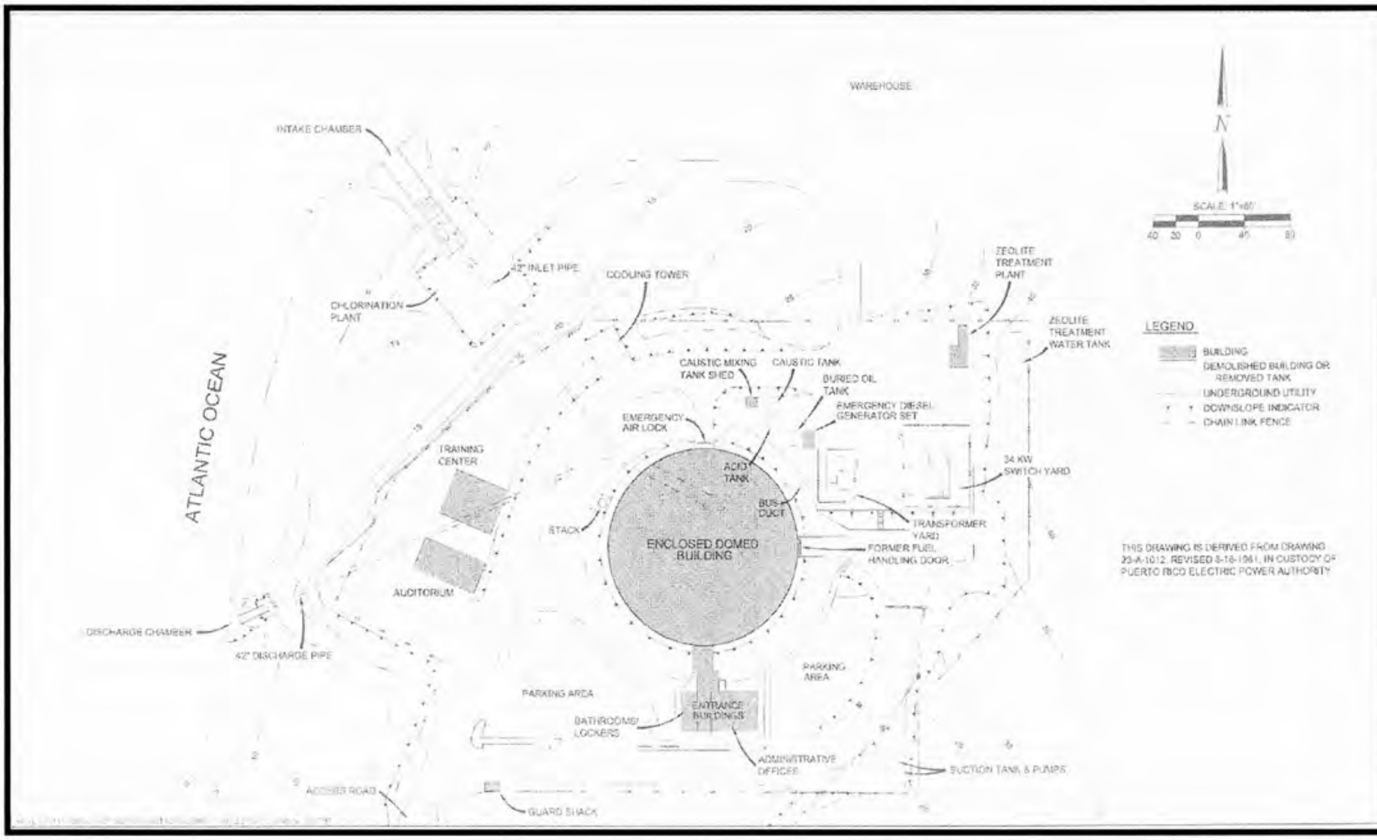
Auditorium

Auditorium's interior

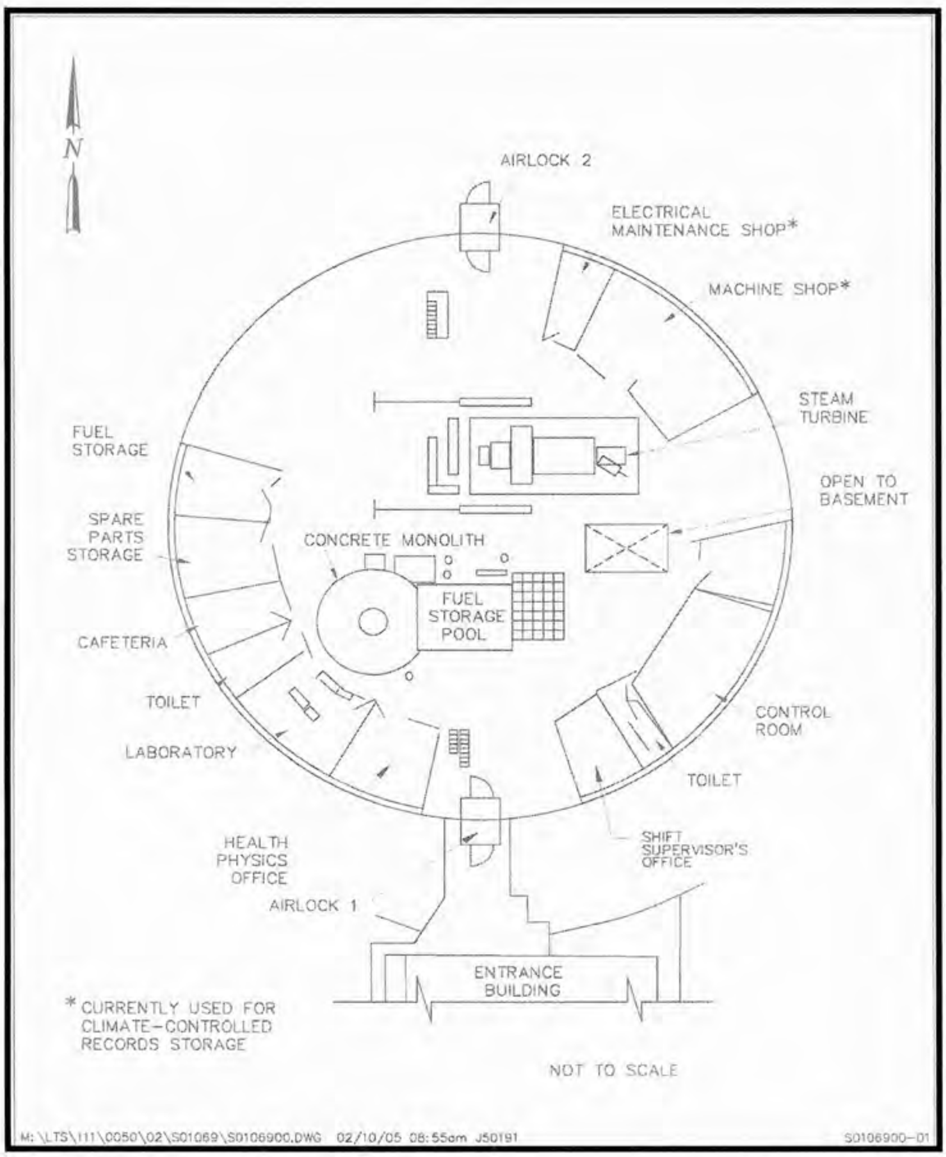
Training Center

Auditorium's back terrace.

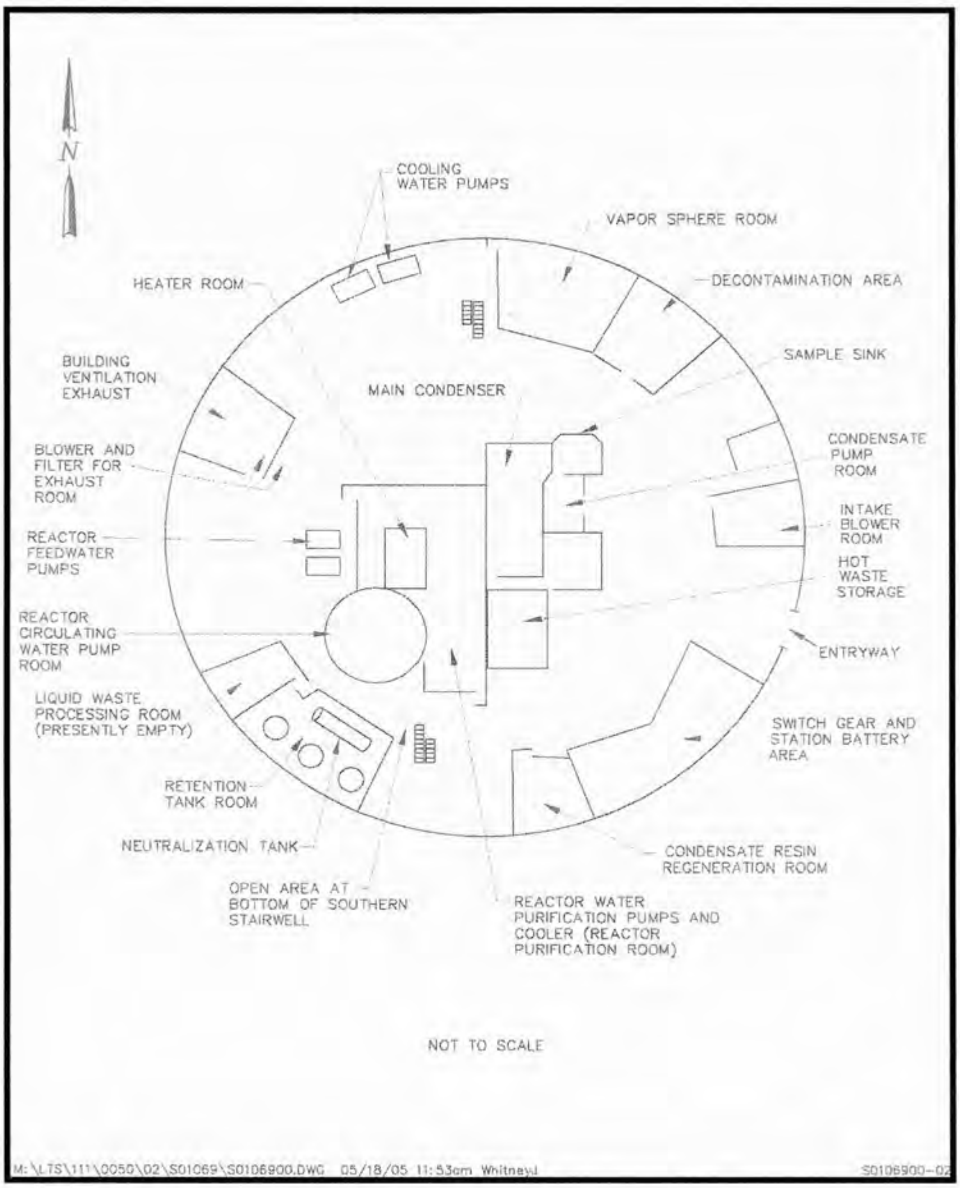
Site Layout


WAREHOUSE
INTAKE CHAMBER
42" INLET PIPE
COOLING TOWER
CHLORINATION PLANT
ATLANTIC OCEAN
ZEOLITE TREATMENT PLANT
ZEOLITE TREATMENT WATER TANK
CAUSTIC MIXING TANK SHED
CAUSTIC TANK
BURIED OIL TANK
EMERGENCY DIESEL GENERATOR SET
EMERGENCY AIR LOCK
TRAINING CENTER
ACID TANK
BUS DUCT
34 KW SWITCH YARD
TRANSFORMER YARD
STACK
ENCLOSED DOMED BUILDING
FORMER FUEL HANDLING DOOR
AUDITORIUM
DISCHARGE CHAMBER
42" DISCHARGE PIPE
PARKING AREA
PARKING AREA
ENTRANCE BUILDINGS
BATHROOMS/ LOCKERS
ADMINISTRATIVE OFFICES
SUCTION TANK & PUMPS
ACCESS ROAD
GUARD SHACK
N
SCALE: 1"=80'
40 20 0 40 80
LEGEND
BUILDING
DEMOLISHED BUILDING OR REMOVED TANK
UNDERGROUND UTILITY
DOWNSLOPE INDICATOR
CHAIN LINK FENCE
THIS DRAWING IS DERIVED FROM DRAWING 23-A-1012, REVISED 8-18-1961, IN CUSTODY OF PUERTO RICO ELECTRIC POWER AUTHORITY

Main floor of Domed Building



Basement of Domed Building



United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section _____ Page ___

SUPPLEMENTARY LISTING RECORD

NRIS Reference Number: 07001194 Date Listed: 11/14/2007

Boiling Nuclear Superheater (BONUS) Reactor Facility — Rincon — PR
Property Name — County — State

N/A
Multiple Name

This property is listed in the National Register of Historic Places in accordance with the attached nomination documentation subject to the following exceptions, exclusions, or amendments, notwithstanding the National Park Service certification included in the nomination documentation.

Signature of the Keeper — 11/14/2007 Date of Action

Amended Items in Nomination:

Historic Function:
The Historic Functions are amended to add: *Government/Public Works (nuclear plant).*
[This reflects the complex's origins under the Atomic Energy Commission's government-funded nuclear research program.]

Description:
The current description narrative does not provide information on several minor outbuildings, which are still extant within the 5-acre complex. These are minor support elements, many in poor structural condition, and while dating from the historic period, they are not included in the resource count due to their relative size, condition, and function. (See attached report for further descriptive info.)

Significance:
Architect/Builder is amended to read: *Atomic Energy Commission/Maxon Construction Company/Chicago Bridge Construction Company/General Nuclear Engineering Corp (Reactor).*

Geographical Data:
The Verbal Boundary Description is amended to clarify that the nominated boundaries do not encompass the entire lot identified as "095-000-004-03" (10), which represents the original 137-acre facility reservation (10.16). The nominated boundaries are identified on the attached Site Layout map (10.22) as the five-acre parcel centered on the domed building that is encompassed within the 6' tall perimeter security fence line.

These clarifications were confirmed with the PR SHPO office.

DISTRIBUTION:
National Register property file
Nominating Authority (without nomination attachment)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

REQUESTED ACTION: NOMINATION

PROPERTY NAME: Boiling Nuclear Superheater (BONUS) Reactor Facility

MULTIPLE NAME:

STATE & COUNTY: PUERTO RICO, Rincon

DATE RECEIVED: 10/01/07 DATE OF PENDING LIST: 10/22/07
DATE OF 16TH DAY: 11/06/07 DATE OF 45TH DAY: 11/14/07
DATE OF WEEKLY LIST:

REFERENCE NUMBER: 07001194

REASONS FOR REVIEW:

APPEAL:	N	DATA PROBLEM:	N	LANDSCAPE:	N	LESS THAN 50 YEARS:	N
OTHER:	N	PDIL:	N	PERIOD:	N	PROGRAM UNAPPROVED:	N
REQUEST:	N	SAMPLE:	N	SLR DRAFT:	N	NATIONAL:	N

COMMENT WAIVER: N

___ACCEPT ___RETURN ___REJECT ____________DATE

ABSTRACT/SUMMARY COMMENTS:

The Boiling Nuclear Superheater (BONUS) Reactor Facility is of statewide significance under National Register Criteria A and C in the areas of Engineering, Industry, and Social History. Substantially completed by 1963 and on-line by 1964, the facility is an exceptionally significant and well-preserved example of mid-twentieth century nuclear engineering technology. Created as a small-scale, prototype nuclear reactor–one of only two of its kind–the BONUS research facility was intended to establish the technical feasibility and economic potential of nuclear "superheater" reactors. A joint project between the U. S. Atomic Energy Commission (AEC) and the Puerto Rico Water Resources Authority (local power authority), the BONUS complex was directly associated with the AEC's "Power Demonstration Reactor Program," initiated in 1955 during America's pioneering era of peaceful nuclear energy research and development. Facilities such as BONUS, even though relatively short-lived, were vital to the ongoing development of viable nuclear energy programs in the United States. The completion and operation of the BONUS research facility, the first of its type in Puerto Rico and Latin America, also represented an important milestone in the political and social development of Puerto Rico, as the island worked to emerge from its largely agrarian economy into a viable, modern, technological society, reflecting important national policies of both the Puerto Rico government and the Kennedy and Johnson administrations (Operation Bootstrap, Alliance for Progress), which sought to open up Puerto Rico and Latin America to U.S. technology, science, industry and economic development, while simultaneously deflecting the lure of communism.

Despite the entombment of critical elements of the original facility (pressure vessel) for safety reasons (radioactivity containment), the complex retains a remarkably high level of overall integrity and readily conveys its engineering and technological significance as a pioneering nuclear testing facility from the 1960s. The level of integrity was greatly aided by the facility's rather limited operational life and immediate deactivation and decommissioning by 1970. As a unique technological research and training facility the BONUS site is of statewide significance. With additional research and comparative analysis regarding other extant components of the early, non-military, U.S. nuclear program from this period, national significance might be considered.

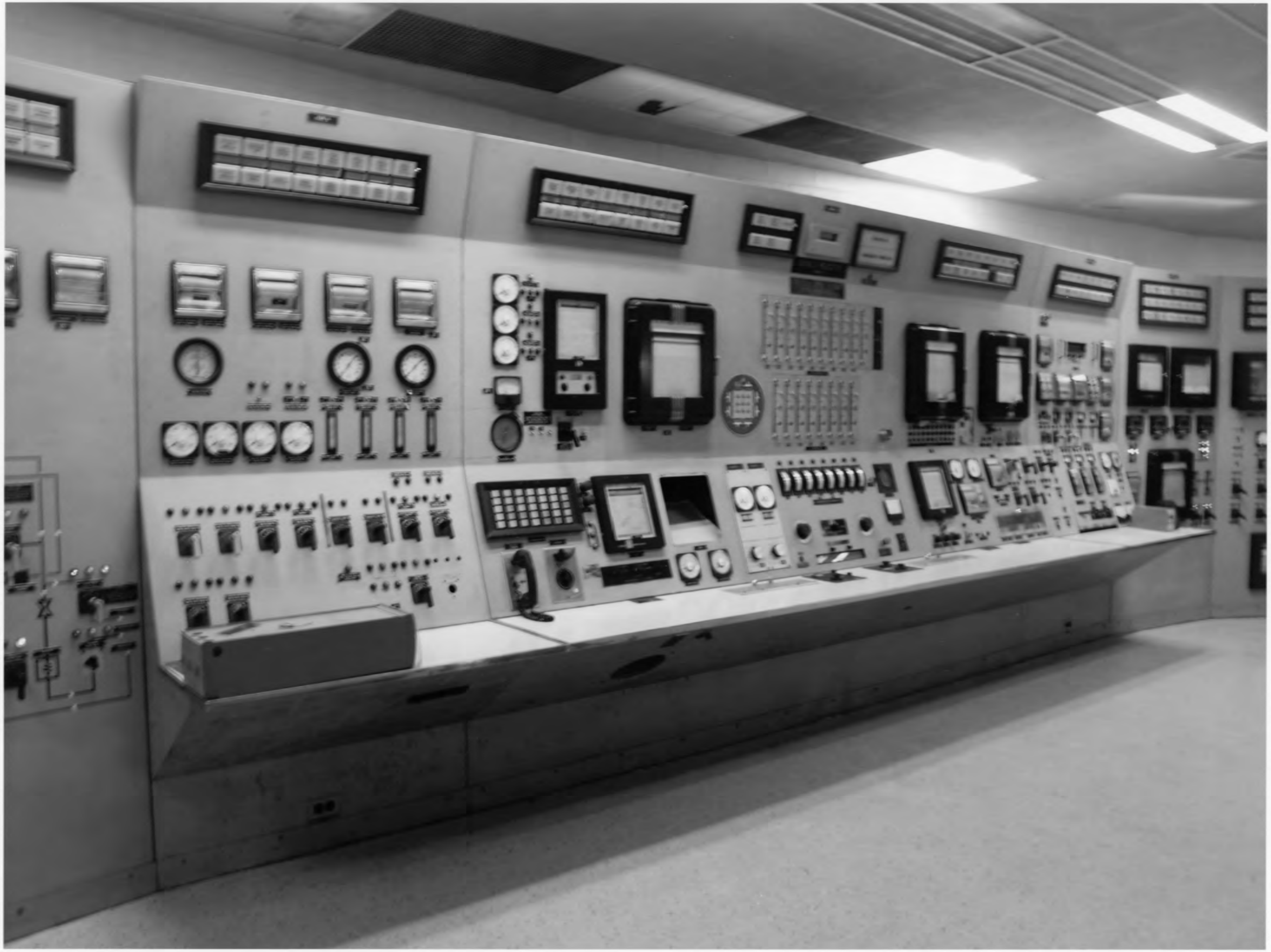
RECOM./CRITERIA Accept Criteria A+C

REVIEWER Paul R. Lusignan DISCIPLINE Historian

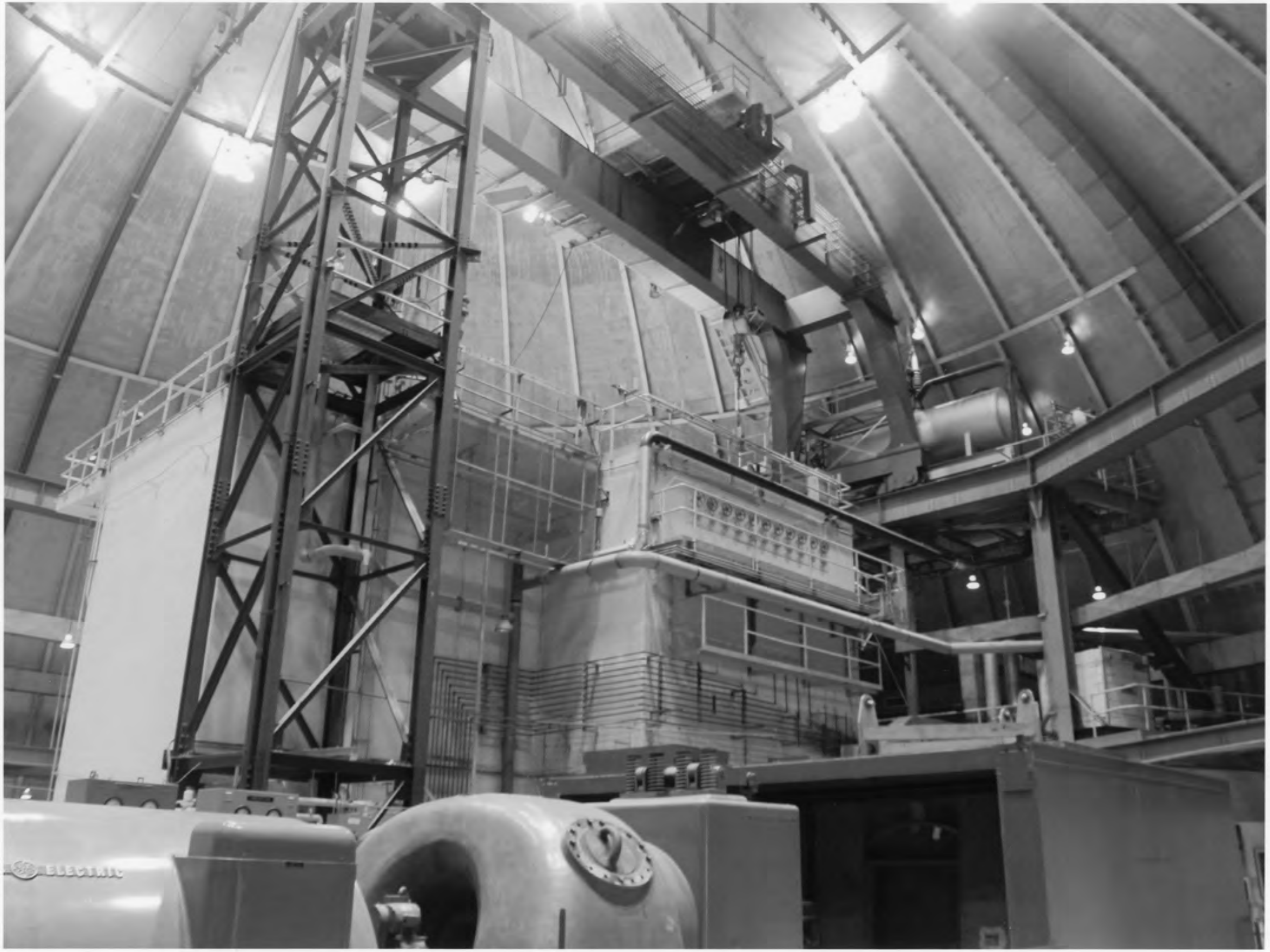
TELEPHONE 202.354.2229 DATE 11/14/2007

DOCUMENTATION see attached comments Y/N see attached SLR Y/N

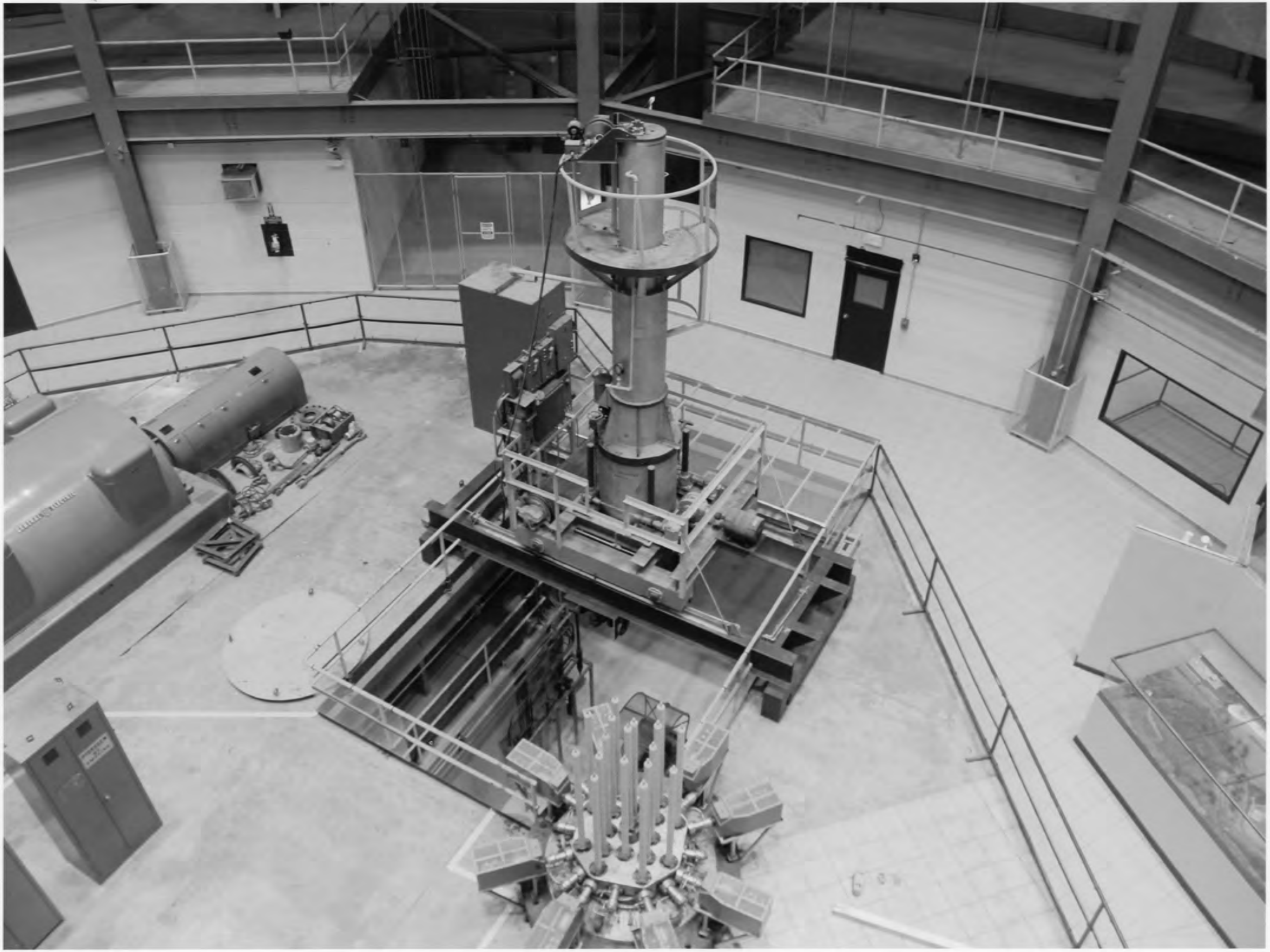
If a nomination is returned to the nominating authority, the nomination is no longer under consideration by the NPS.




EINSTEIN


ELECTRIC

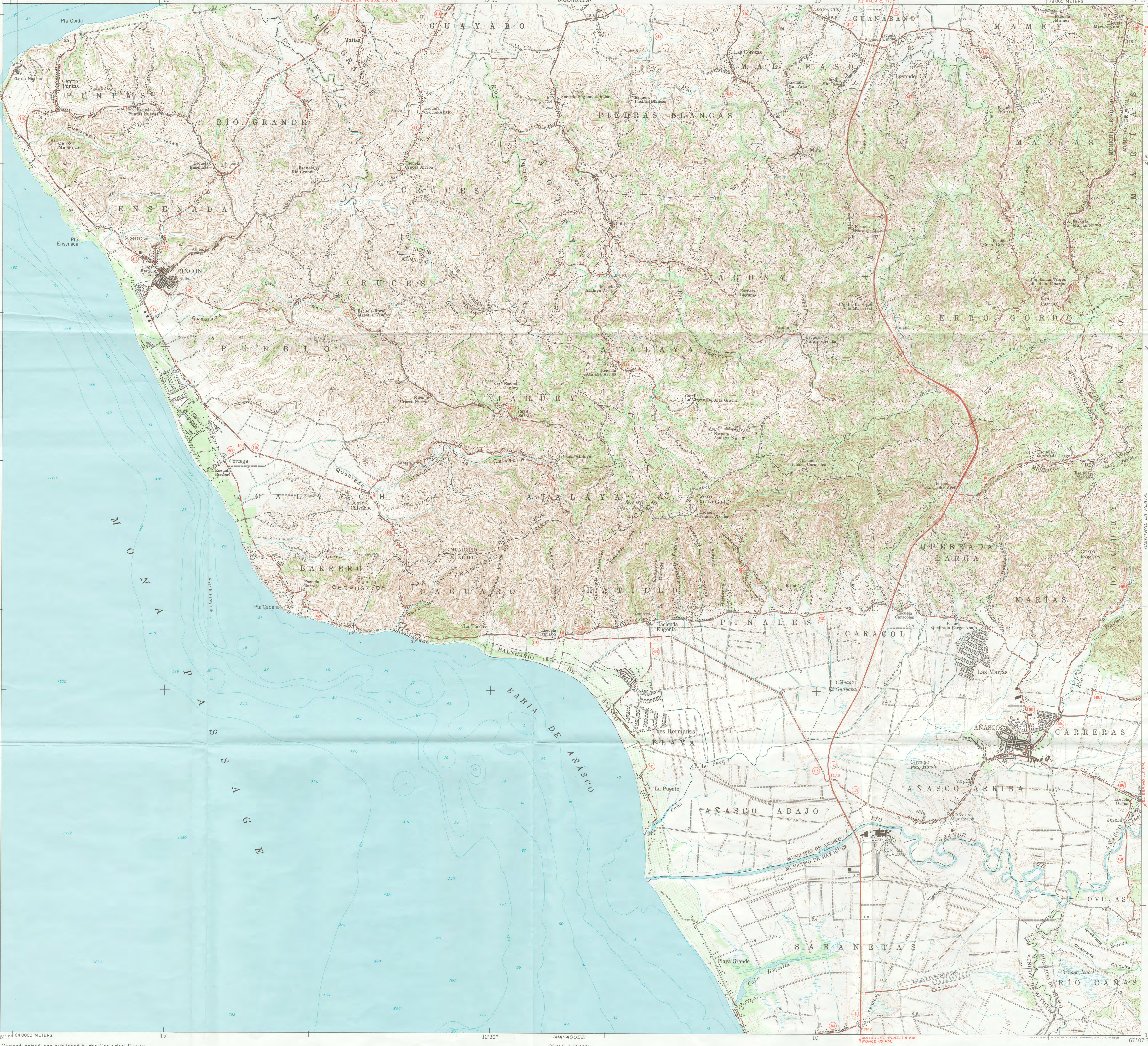

NOTICE



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COMMONWEALTH OF PUERTO RICO
DEPARTMENT OF PUBLIC WORKS
FRANCISCO LIZARDI, SECRETARY

RINCÓN QUADRANGLE
PUERTO RICO
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by planetable surveys 1938–1939. Revised from aerial photographs taken 1963 Field checked 1966

Selected hydrographic data compiled from USC&GS Chart 901 (1965)
This information is not intended for navigational purposes

Polyconic projection. Puerto Rico datum, 1940 adjustment
2000-meter grid based on Puerto Rico coordinate system

Barrio and municipality boundaries by the Puerto Rico Planning Board

Kilometric reference distances shown in red

6½°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1966

SCALE 1:20 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 5 METERS
DOTTED LINES REPRESENT 1-METER CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.2 METERS

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
AND DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS, SAN JUAN, P. R. 00910
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Bonus, Rincón Puerto Rico

Zone - 19
Easting - 682925
Northing - 2031463

PUERTO RICO
QUADRANGLE LOCATION

ROAD CLASSIFICATION

Heavy-duty	Light-duty
Medium-duty	Unimproved dirt

Insular Route

000075

RINCÓN, P. R.
N1815—W6707.5/7.5X8.75
1966

Oficina del Gobernador • Oficina Estatal de Conservación Histórica
oech
Office of the Governor • State Historic Preservation Office
shpo

September 6, 2007

Ms. Janet Snyder Matthews, Ph.D.
National Park Service 2280
National Register of Historic Places
1201 "I" Eye Street, N.W., 8th floor
Washington, D. C. 20005

SUBMISSION: BOILING NUCLEAR SUPERHEATER (BONUS) REACTOR FACILITY

Dear Ms. Snyder: Jan

We are pleased to submit for inclusion in the National Register of Historic Places the nomination of the **Boiling Nuclear Superheater (BONUS) Reactor Facility**, located in the Municipality of Rincón, Puerto Rico.

If you should have any questions on the nomination, please contact Arch. Berenice Sueiro, Conservation Manager.

Sincerely, Warm regards!

Aida Belén Rivera Ruiz, Archaeologist
State Historic Preservation Officer

ABRR/BRS/JLS/jvr

Enclosure

P.O. Box 9066581
San Juan, PR 00906-6581
Tel: (787) 721-3737
Fax: (787) 722-3622
www.oech.gobierno.pr

BONUS, Puerto Rico, Decommissioned Reactor

FACT SHEET

This fact sheet provides information about the Defense Decontamination and Decommissioning Program Boiling Nuclear Superheater (BONUS) reactor located northwest of Rincón, Puerto Rico. The site is jointly managed by the Puerto Rico Electric Power Authority and U.S. Department of Energy Office of Legacy Management.

Site Description and History

The decommissioned Boiling Nuclear Superheater (BONUS) reactor, located northwest of Rincón, Puerto Rico, was developed as a prototype nuclear power plant to investigate the technical and economic feasibility of the integral boiling-superheating concept. This small-scale nuclear reactor produced saturated steam in the central portion of the reactor core, superheated it in four surrounding "superheater" sections of the same core, and then used the superheated steam in a direct loop to drive a turbine generator.

It was one of only two boiling-water superheater reactors ever developed in the United States. The reactor was designed to be large enough to evaluate the major features of the integral boiling-superheating concept realistically without the high construction and operating costs associated with a large plant.

Construction of the reactor began in 1960 through a combined effort of the U.S. Atomic Energy Commission and Puerto Rico Water Resources Authority. The reactor first achieved a controlled nuclear chain reaction on April 13, 1964. It 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. Operation at full power (50 megawatts of thermal energy) and full temperature (900 °F [482 °C] steam) was achieved in September 1965, and tests demonstrated satisfactory operation at 10 percent over power in November 1965.

Operation of the BONUS reactor was terminated in June 1968 because of technical difficulties and the ensuing need for high-cost modifications. The Puerto Rico Water Resources Authority decommissioned the reactor between 1969 and 1970. During decommissioning, all special nuclear materials (fuel) and certain highly activated components (e.g., control rods and shims) were removed to the mainland, 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.

Location of the BONUS, Puerto Rico, Decommissioned Reactor

General decontamination of the reactor was performed with the goal of meeting unrestricted use criteria in all accessible areas of the building. Residual radioactive materials remaining in the structure were isolated or shielded to protect site visitors and workers. During subsequent years, more radioactive contamination was identified in portions of the building, and additional cleanup and shielding activities were conducted in the 1990s and early 2000s.

Regulatory Setting

The U.S. Department of Energy (DOE), as the successor agency to the U.S. Atomic Energy Commission, and in accordance with the Atomic Energy Act of 1954, holds title to and is responsible for the radioactive materials that remain at the BONUS site. The Puerto Rico Electric Power Authority (PREPA), as the successor agency to the Puerto Rico Water Resources Authority, owns the land, buildings, and other improvements. Responsibilities for the long-term surveillance

BONUS, Puerto Rico, Decommissioned Reactor

and maintenance of the site are established for DOE and PREPA through a *Memorandum of Understanding between the U.S. Department of Energy Office of Legacy Management and the Puerto Rico Electric Power Authority for the Use, Maintenance, and Control of the Boiling Nuclear Superheater Reactor Facility in Rincón, Puerto Rico* (pending). Legacy management activities (explained below) and other responsibilities assigned to DOE will be conducted by the DOE Office of Legacy Management.

DOE, as the authorized custodian of the radioactive materials remaining at the BONUS site, will comply with the following regulation and guidance. Title 10 *Code of Federal Regulations (CFR)* Part 835 establishes radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation resulting from the conduct of DOE activities. DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* establishes standards and requirements for DOE operations with respect to protection of the environment and members of the public from risk of radiological exposure.

PREPA, in accordance with the Memorandum of Understanding, shall maintain compliance with applicable portions of Title 10 CFR Part 835 and DOE Order 5400.5 through its annual and quarterly monitoring of the BONUS site to ensure worker and public safety.

Legacy Management Activities

DOE and PREPA are responsible for ensuring that the BONUS site continues to be protective of human health and the environment. These agencies will also preserve site information.

DOE will conduct independent inspections of the site and may accompany PREPA personnel during regularly scheduled inspections. DOE will evaluate radiological and structural monitoring results and procedures and will publish its findings annually. DOE will maintain copies of site records that document radioactive materials and their disposition.

PREPA will conduct quarterly and annual surveys to assess radiological conditions throughout the BONUS site. Results of the surveys will be available to the public and government agencies. PREPA also will conduct quarterly visual inspections to evaluate the structural adequacy of the buildings and entombment structure and the condition of the areas open to public access. PREPA will maintain site records pertaining to BONUS design, construction, operation, decommissioning, and post-decommissioning monitoring.

Public Involvement

DOE encourages public participation in the surveillance and maintenance process at the BONUS site. DOE will accomplish this by making site information available through its website at http://www.LM.doe.gov and responding to citizens' requests.

PREPA intends to open the main floor of the BONUS building as a museum, in which numerous displays will recount the history of the site as well as the development of electric power and nuclear energy. DOE completed an environmental assessment in 2003 that indicated no unacceptable risk to human health or the environment if the main floor is used as a museum.

Contacts

Site-specific documents related to the BONUS reactor are available on the DOE Legacy Management website at http://www.LM.doe.gov/land/sites/pr/bonus/bonus.htm.

For more information about the DOE Legacy Management activities at the BONUS site, contact

U.S. Department of Energy
Office of Legacy Management
2597 B¾ Road, Grand Junction, CO 81503

Ron Staubly, Project Manager (304) 285-4991

(970) 248-6070 (monitored continuously) or
(877) 695-5322 (toll free)

or

Puerto Rico Electric Power Authority
P.O. Box 364267
San Juan, PR 00936–4267

Arsenio Reyes, Acting Supervisor (787) 289-4989
(787) 289-4988

DOE–LM/GJ596–2004

Office of Legacy Management

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

May 2005

U.S. Department of Energy

*Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
Approved for public release; distribution is unlimited.*

DOE-LM/GJ596-2004

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

May 2005

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491 for the U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado

S0109100

2.0 Site Conditions

2.1 Area Description

Puerto Rico is located approximately 1,000 miles (1,600 kilometers [km]) southeast of Miami, Florida, and approximately 500 miles (800 km) north of Venezuela. The topography of Puerto Rico is generally mountainous, except for the coastal areas. The BONUS facility is located in the coastal lowlands near Rincón, Puerto Rico, on the western coast (Figure 2–1). Land use in the city of Rincón, located 2 miles (3.2 km) to the 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 1997 population of Rincón was around 14,000 (U.S. Census Bureau Website).

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 degrees Fahrenheit (°F) (27 degrees Celsius [°C]). The U.S. Weather Bureau in San Juan, Puerto Rico, has measured all-time maximum and minimum temperatures of 97 °F (36 °C) and 70 °F (21 °C), respectively. Depending upon location, average annual precipitation in the coastal regions ranges between 40 and 150 inches (101 to 381 centimeters [cm]) per year, 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; that is, moisture-laden air is cooled while ascending over the mountains, causing condensation in the form of rain. The prevailing wind direction in the area is from the east over most of the island, 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 San Ciriaco in August 1899, Hurricane San Ciprian in September 1932, and Hurricane Georges in September 1998. In each case, the storms 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 (240 km per hour) (PWRA 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 storm water 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, located on the westernmost coastal point (Punta Higuera) of Puerto Rico near a U.S. Coast Guard lighthouse (Figure 2–1). The facility lies within a 5-acre (2-hectare) fenced area and is 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) and which served primarily as a buffer zone when the plant was in operation. Warehouses, the chlorination plant, and water tanks were also located in this area. The 6-foot- (1.8-m-) high, chain-link security fence is topped with three strands of barbed wire.

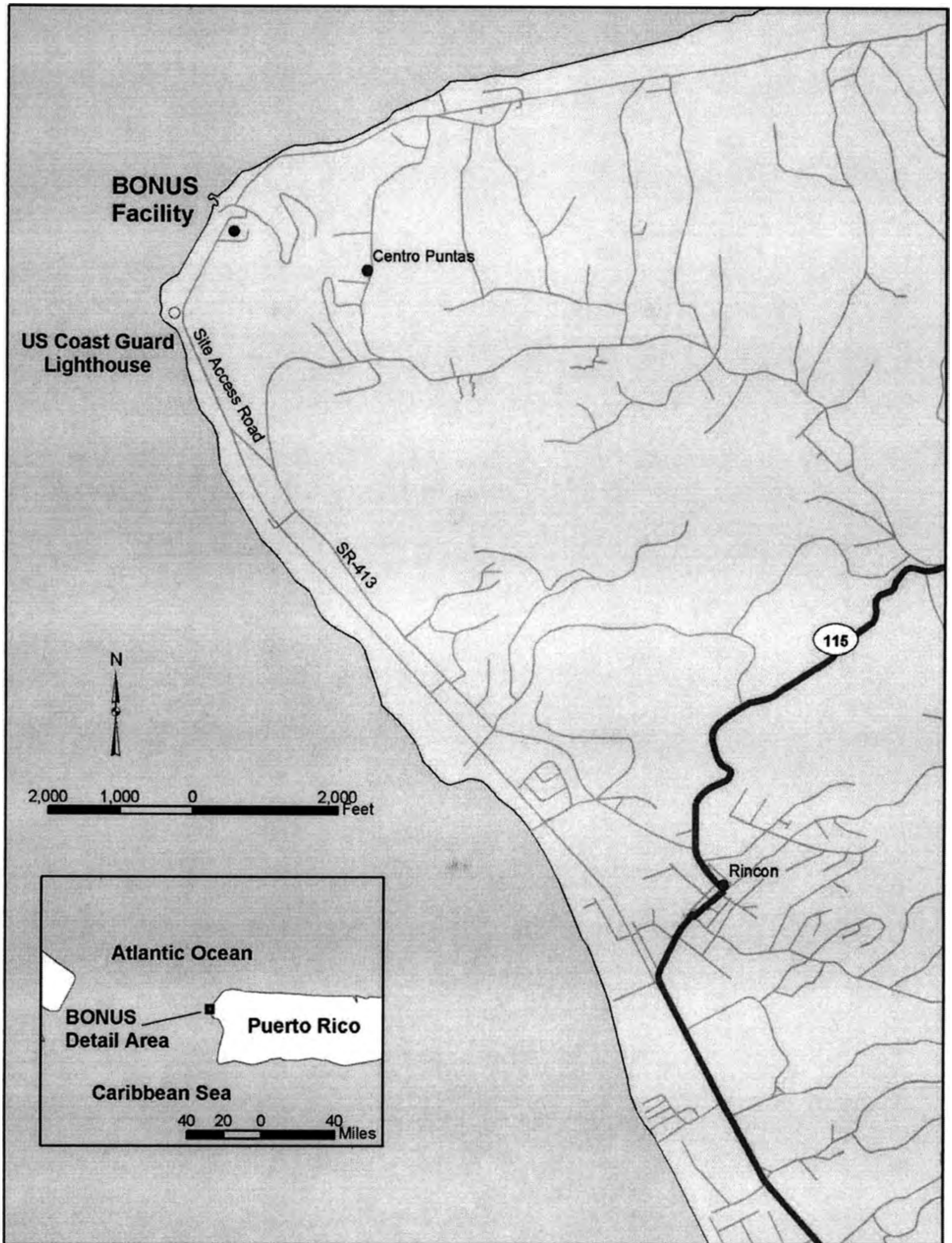


Figure 2–1. Location of the BONUS Facility, Rincón, Puerto Rico

Access through the entrance gate is controlled by a full-time security guard contracted by PREPA, who is stationed in a guard shack (Figure 2–2). 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 abut the PREPA property.

Average elevation of the enclosed domed building is approximately 25 feet (7.6 meters [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 bathrooms and lockers building and the administrative offices building, connected by a breezeway), auditorium (also known as the theater), Training Center, and guard shack—and other smaller support structures and facilities. Figure 2–2 shows the general site layout.

Enclosed Domed Building: The enclosed domed building consists of three levels: the basement (Figure 2–3), main floor (Figure 2–4), 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 radiological 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 that is open to the main floor 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 located at the basement; 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 5400.5 was identified in some areas of the basement (see Section 2.5) and was removed or fixed in summer 2004 (URS Ltd. report pending). In accordance with the Memorandum of Agreement (DOE 2003c), the DOE Office of Environmental Management at Oak Ridge intends to cover fixed contamination on the floor with concrete before transition to the DOE Office of Legacy Management is 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 annually by PREPA staff or contractors.

Main Floor: On the center of 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

[1] Originally, access to the entire 137 acres comprising the BONUS facility was controlled at a guard shack located at the start of the paved road were 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 became a tourist attraction. Before that, access to the lighthouse was via the beach.

plexiglass panels mounted on steel hand railing surround the center area and restrict public 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.

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 in 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 by 2 feet by 10 inches [183 by 61 by 25 cm] thick) and several lead blocks were placed over the fixed radiological contamination with the highest activity. No removable radioactivity above MDAs is present on the main floor or walls.

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

Entrance Buildings: These concrete-block buildings consist of the bathroom and locker rooms building and the administrative offices building separated by a covered breezeway. These buildings are located 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 located 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 located 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, located near the entrance gate, is currently used for site security and access control. It does not contain radiological contamination.

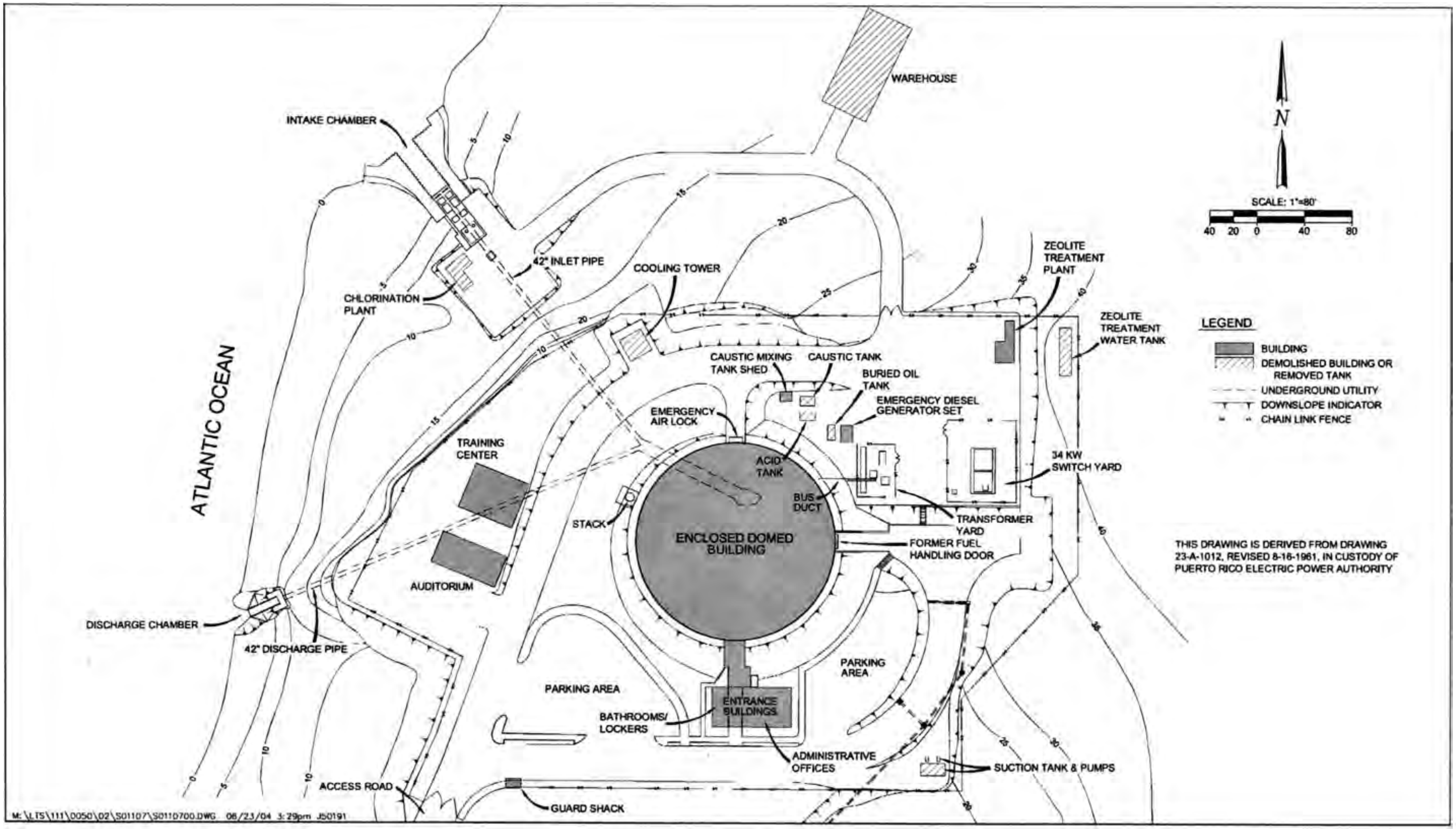


Figure 2–2. Site Layout of BONUS Facility, Rincón, Puerto Rico

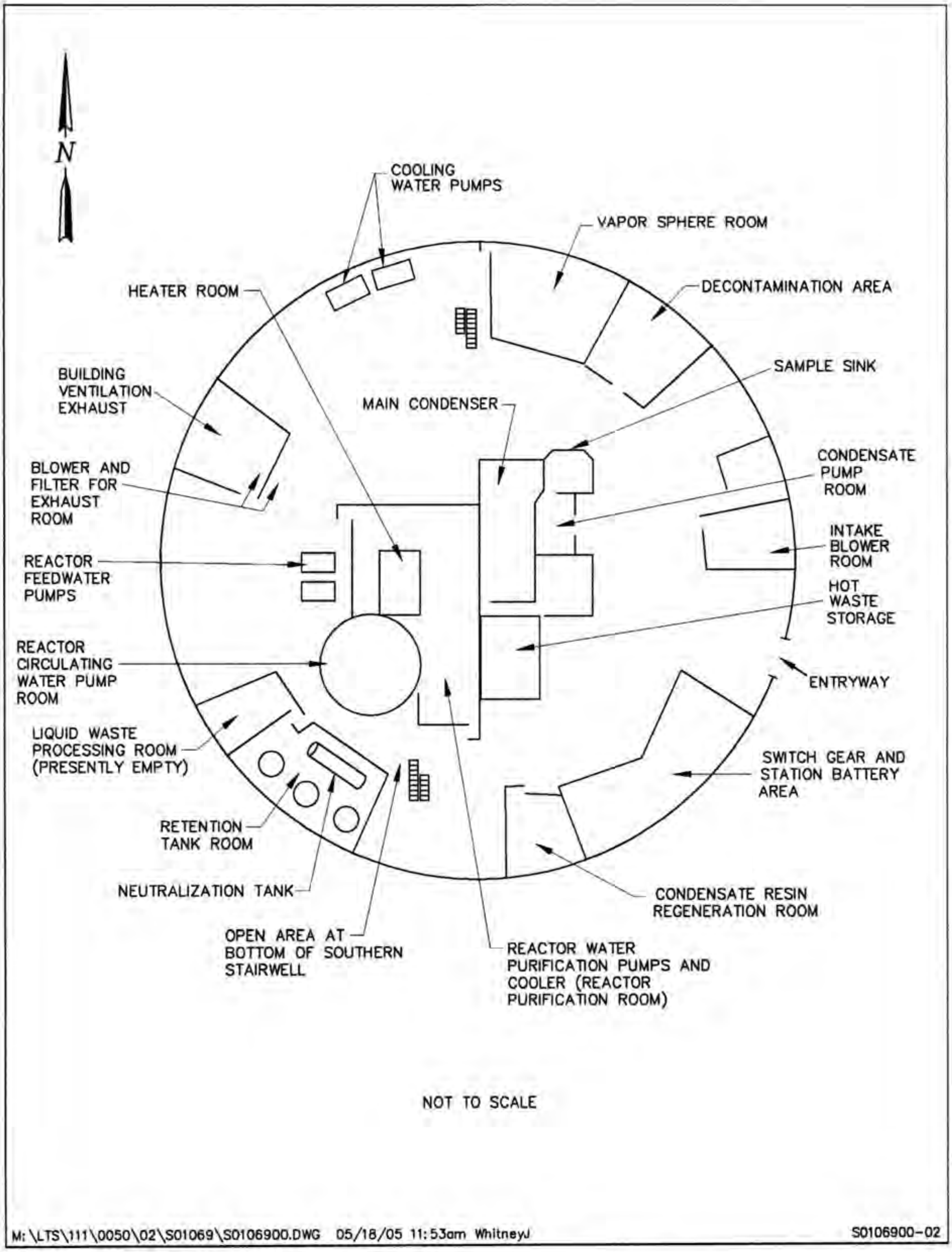


Figure 2–3. Basement Level of the BONUS Enclosed Domed Building, Rincón, Puerto Rico

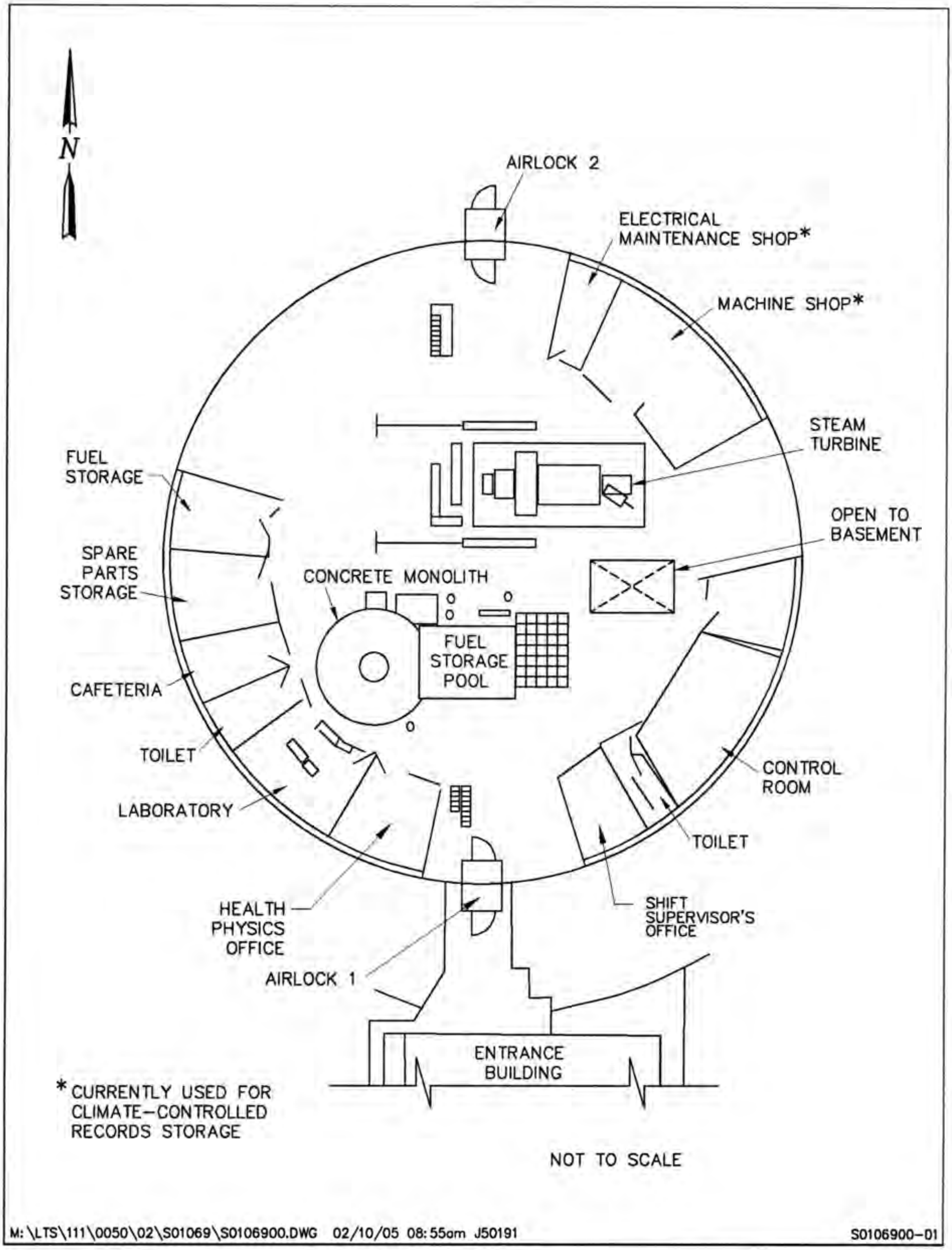


Figure 2–4. Main Floor of the BONUS Enclosed Domed Building, Rincón, Puerto Rico

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. Before responsibility for post-closure care of the facility is transferred to the DOE Office of Legacy Management, the DOE Office of Environment Management intends to fix the contamination by filling the USTs with portland cement grout (DOE 2003c).

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 percent. It leads from State Road 413 through the lighthouse parking lot, then 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- (1.8-m-) high chain link 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 crushed stone base and topped with bituminous asphalt pavement.

Landscaping: Landscaping consists of approximately 27,770 square feet (2,580 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 located in the northeast corner of the site. It is still in place but is not operational. A 6-foot- (1.8-m-) high, galvanized steel, chain-link fence with a 12-foot (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 (97 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 feet by 16 feet (9 m by 5 m). Only the concrete structure remains today.

Drainage System: This system collects storm water 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, located 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. Currently, the structures are 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 2–1 shows the location of the site in relation to local features and roads. Access to the site is through PREPA. The primary contact for accessing the site is:

Acting Supervisor,
Environmental Studies Department
Puerto Rico Electric Power Authority
Rincón, Puerto Rico
(787) 289-4989, -4988
Attention: Arsenio Reyes (or successor)

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 the 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 percent over-power in November 1965 (West and Fragoso 1966).

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 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, which required high cost modifications. 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 Superheating 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 located 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 imbedded 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 and in 2001 are presented in Table 2–1. Estimates of the radiological inventory in the piping and other systems external to the concrete monolith entombment following decommissioning are presented in Table 2–2. 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 Tables 2–1 and 2–2, nickel-63 is the predominant radionuclide remaining in the entombed materials, and cesium-137 is the predominant radionuclide remaining in the external systems.