5A Structural Design
Bases

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APPENDIX 5A

STRUCTURAL DESIGN BASES

The design bases for normal operating conditions are governed by the applicable building design codes. The basic design criterion for the worst loss-of-coolant accident and seismic conditions is that there shall be no loss of function if that function is related to public safety.

AEC publication TID 7024, "Nuclear Reactors and Earthquake", as amplified herein will be used as the basic design guide for seismic analysis.

1. CLASSES OF STRUCTURES AND SYSTEMS

The plant structures and process systems will be classified according to their function and the degree of integrity required to protect the public. These classes are:

1.1 CLASS 1

Class 1 structures and systems are those which prevent uncontrolled release of radioactivity and are designed to withstand all loadings without loss of function. When a system as a whole is referred to as Class 1, certain less essential portions (not associated with loss of function) of the system may later be designated under Class 2 or 3, as appropriate. Examples of Class 1 structures and systems include the following:

Reactor building and its penetrations,
Polar Crane,
Reactor vessel and its internals including
control rod drive assemblies,
Recirculated cooling water systems,
Reactor coolant system including vents and drains
within containment,
Low pressure injection and decay heat removal system,
High pressure injection and purification system,
Containment safeguards systems including their
electrical distribution systems,
Fuel storage system,
Reactor control room and equipment,
Waste disposal system.

1.2 CLASS 2

Class 2 structures and systems are those whose limited damage would not result in a release of radioactivity and would permit a controlled plant shutdown but could interrupt power generation. Examples of Class 2 structures and systems include the following:

Secondary coolant system,
Electric power system,

Turbine, auxiliary and waste disposal buildings except as included in Class 1 above.

1.3 CLASS 3

Class 3 structures and systems are those whose failure could inconvenience operation, but which are not essential to power generation, orderly shutdown or maintenance of the reactor in a safe condition. They include all structures and systems not included in Classes 1 and 2.

2 DESIGN BASES FOR CLASS 1 STRUCTURES

2.1 NORMAL OPERATION

For loads experienced in normal plant operation, Class 1 structures are designed in accordance with design methods of accepted standards and codes applicable.

2.2 ACCIDENT, WIND AND SEISMIC CONDITIONS

The Class 1 structures are proportioned to maintain elastic behavior when subjected to various combinations of dead loads, accident loads, thermal loads and wind or seismic loads. The upper limit of elastic behavior is considered to be the yield strength of the effective load-carrying structural materials. The yield strength for steel (including reinforcing steel) is considered to be the minimum given in the appropriate ASTM specification. Concrete structures will be designed for ductile behavior wherever possible; that is, with steel stress controlling the design. The values for concrete, as given in the ultimate strength design portion of the ACI 318-63 Code, will be used in determining "Y", the required yield strength of the structure.

The design loads applied to the structures are increased by load factors based on the probability and conservatism of the predicted normal design loads.

The final design of Class 1 structures satisfies the following loading combinations and factors:

$Y = 1/\phi\ (1.0D + 1.0P + 1.0T + E')$
$Y = 1/\phi\ (1.05D + 1.25P + 1.0T + 1.25E \text{ or } W)$
$Y = 1/\phi\ (1.05D + 1.5P + 1.0T)$
$Y = 1/\phi\ (1.0D + 1.0W_t + 1.0P_i)$ for Tornado Forces.
(Use 0.95 where dead load subtracts from critical stress.)
(Wind, W, to replace earthquake, E, in the above formula where wind stresses control)
Where Y = required yield strength of the structure as defined above.
D = dead loads of structure and equipment plus any other permanent loadings contributing stress, such as hydrostatic or soils. In addition, a portion of "live load" should be added when it includes piping, cable trays, etc., suspended from floors and an allowance should be made for future additional permanent loads.
P = design accident pressure.
T = thermal loads based on a temperature corresponding to the factored design accident pressure.
E = seismic load based on design earthquake.

E' = seismic load based on maximum hypothetical earthquake.
W = wind load.
W_t = stress induced by tornado wind velocity (drag, lift and torsion).
P_i = stress due to differential pressure.
Ø = capacity reduction factor.
- Ø = 0.90 for concrete in flexure.
- Ø = 0.85 for tension, shear, bond and anchorage in concrete.
- Ø = 0.75 for spirally reinforced concrete compression members.
- Ø = 0.70 for tied compression members.
- Ø = 0.90 for fabricated structural steel.
- Ø = 0.90 for mild reinforcing steel (not prestressed) in direct tension excluding splices.
- Ø = 0.85 for mild reinforcing steel with welded or mechanical splices (for lap splices, Ø = 0.85 as above for bond and anchorage).
- Ø = 0.95 for prestressed tendons in direct tension.

The design ground acceleration at the site is given in Section 2.6, "Seismology."

Seismic loads on structures and components are determined on the basis of dynamic analysis using the average velocity and acceleration spectrum curves shown in Appendix 2B.

Where realistic evaluation of dynamic properties is not possible, the maximum value of the acceleration response curve for the appropriate damping factor is used.

DAMPING FACTORS

Item	Per Cent of Critical Damping
Welded carbon and stainless steel assemblies (This includes reactor internals, supports and similar weldments.)	1
Steel Frame Structures (Both welded and high strength bolted)	2
Reinforced concrete equipment supports	2
Reinforced concrete frames and buildings	5
Prestressed concrete structures	
Under design earthquake forces	2
Under maximum hypothetical earthquake	5
Vital Piping	0.5

Seismic forces are applied in the vertical and in any horizontal direction. The horizontal and vertical components of ground motion are applied simultaneously and the two components considered occurring in such a way that the stresses are directly additive.

The wind loads are determined from the fastest mile of wind for a 100-year occurrence as shown in Figure 1(b) of Reference 4. This is 95 mph at the site.

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3 DESIGN BASES FOR CLASS 2 STRUCTURES

3.1 NORMAL OPERATION

For loads experienced in normal plant operation, Class 2 structures are designed in accordance with design methods of accepted standards and codes insofar as they are applicable.

3.2 ACCIDENT AND SEISMIC CONDITIONS

For Class 2 structures, the working stress design method will be used and stress will be in accordance with ACI 318-63 and the AISC Codes.

4 DESIGN BASES FOR CLASS 3 STRUCTURES

Class 3 structures are designed in accordance with design methods of accepted standards and codes insofar as they are applicable.

5 WIND LOADING FOR CLASS 2 AND 3 STRUCTURES

The wind loads are determined from the fastest mile of wind for a 100-year occurrence as shown in Figure 1(b) of Reference 4. This is 95 mph at the site.

6 LOADINGS COMMON TO ALL STRUCTURES

6.1 ICE OR SNOW LOADING

A uniform distributed live load of 20 pounds per square foot is considered for roofs as stated in Section 1203.2 of the Southern Standard Building Code.

6.2 FLOODING

No loads are considered for floods or inundation. Refer to paragraph 5.1.2.3.4.

6.3 TEMPERATURE

The station is designed for an ambient temperature range of 0 F to + 100 F.

7 MISSILE SHIELDING

Missile barriers inside the Reactor Building are designed to absorb the energy by plastic yielding.

8 REFERENCES

1. Nuclear Reactors and Earthquakes, AEC Publication TID-7024.
2. Design of Nuclear Power Reactors Against Earthquakes, Housner, G. W., Proceedings of the Second World Conference on Earthquake Engineering, Volume 1, Japan 1960, Page 133.
3. Behavior of Structures During Earthquakes, Housner, G. W., Journal of the Engineering Mechanics Division, Proceedings of the American Society of Civil Engineers, October 1959, Page 109.
4. Wind Forces on Structures, Task Committee on Wind Forces, ASCE Paper No. 3269.