5A Structural Design Bases

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APPENDIX 5A

STRUCTURAL DESIGN BASES

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APPENDIX 5A

STRUCTURAL DESIGN BASES

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

Structural design for normal operating conditions will be governed by the applicable design codes. The design for the loss-of-coolant accident and maximum seismic condition will ensure no loss of functions when related to public safety.

1 CLASSES OF STRUCTURES AND SYSTEM

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

1.1 CLASS I

Those structures, components, and systems, including instruments and controls, whose failure might cause or increase the severity of a loss-of-coolant accident or result in an uncontrolled release of excessive amounts of radioactivity and those structures and components which are vital to safe shutdown and isolation of the reactor are classified Class I. When a system as a whole is referred to as Class I, certain less essential portions not associated with loss of function of the system may later | 3
be designated under Class II or III as appropriate. Examples of Class I structures, components, and systems are:

a. Reactor Building and its penetrations including plant vent.

b. Reactor Building crane.

c. Reactor vessel and its internals including control rod drive assemblies.

*d. Vital cooling water systems.

e. Primary system including vents and drains within Reactor Building.

*f. Spent fuel cooling system and shutdown cooling system.

*g. Makeup and purification system.

*h. Engineered safeguards systems including their electrical power sources and distribution systems.

*i. Fuel storage pool.

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*k. Waste disposal system.

l. Post-incident air filtration system.

*m. Auxiliary and waste disposal buildings.

*Totally or partially outside the reactor building.

1.2 CLASS II

Those structures, components, and systems which are important to reactor operation but not essential to safe shutdown and isolation of the reactor and whose failure could not result in the release of substantial amounts of radioactivity are classified Class II. Examples of Class II structures, components, and systems are:

a. Secondary coolant system.

b. Electric power system, except emergency systems.

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1.3 CLASS III

Those structures, components, and systems which are not related to reactor operation or containment are classified Class III.

2 CLASS I DESIGN BASES

All structures, components, and systems classified in Class I will be designed in accordance with the following criteria:

a. Primary steady state stresses, when combined with the seismic stress resulting from the response to a ground acceleration of 0.05 g acting horizontally and 0.033 g acting vertically and occurring simultaneously shall be maintained within the allowable working stress limits accepted as good practice and where applicable, set forth in the appropriate design standards, e.g., ASME Boiler and Pressure Vessel Code, ASA B31.1 Code for Pressure Piping, Building Code Requirements for Reinforced Concrete, ACI 318 and AISC Specifications for the Design and Erection of Structural Steel for Buildings.

b. Primary steady state stress when combined with the seismic stress resulting from the response to a ground acceleration of 0.10 acting horizontally and 0.067 g acting vertically and occurring simultaneously, shall be limited so that the function of the component, system, or structure shall not be impaired as to prevent a safe and orderly shutdown of the plant. In the case of Class I piping systems, no stress value will exceed 120 percent of the minimum of the allowable stress limits set forth in USASI Standard Code for Pressure Piping, B31.1.0-1967.

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All major structures will be founded on essentially similar material. Because structures will be founded at various elevations, an evaluation will be made of permanent differential settlements if any. This factor could result in a permanent motion of one building with respect to another which must be accomodated presumably by isolation of the buildings, at least including foundations and concrete superstructures. This presumes that the steel superstructures could be designed to accommodate this motion. Where separation is provided, a sufficient gap (rattle space) is also required to prevent physical interaction due to different seismic response. The foregoing provisions apply to all Class I structures. 1

The permanent and transient motions of one structure with respect to another must also be considered in the analysis of the piping systems. The dynamic analysis provides for the determination of the fundemental periods and mode shapes of the piping system/systems. The model to be used will also include as boundary conditions displacements which may be induced at support points. The effect of shear axial, torsional, and flexural deformations are included in this analysis. Knowing the natural frequencies and mode shapes, the displacements are determined using the response spectra for a single degree of freedom system. After the displacements are determined inertial forces are calculated to obtain internal forces and moments.

Reactor Building Cranes

The polar crane is a Class I component and will be designed along with its supporting structure to satisfy the criteria for Class I structures and components contained in Appendix 5A of the Preliminary Safety Analysis Report.

In order to ensure stability during an earthquake the crane trolley will be tied down to the bridge and the bridge tied down to the runway girder at all times during plant operation.

Crane Brackets

The preliminary design provides for a standard WF-section used as a bracket, welded directly to a continuous bent plate ring that is thicker than the liner. (See Figure 5A-1.) The moment introduced to the bracket will be resisted by two structural tees embedded in the wall. The shear will be transferred from the bracket web plate, through the liner plate, into the stiffener plates, and resisted by bearing of the structural tee web plates.

3 CLASS II DESIGN BASES

All structures, components, and systems classified as Class II will be designed for a ground acceleration of 0.05 g in accordance with procedures of the Uniform Building Code published by the International Conference of Building Officials.

4 CLASS III DESIGN BASES

All structures, components, and systems classified as Class III will be designed in accordance with applicable building code requirements.

5 DAMPING FACTORS

The following gives the damping factors used in the seismic design of components and structures.

Component Or Structure	Per Cent of Critical Damping
1. Reactor Building	2.0
2. Concrete Support structures inside the Reactor Building	2.0
3. Assemblies and Structures	
a) Bolted or Riveted	2.5
b) Welded	1.0
4. Vital Piping Systems	0.5
5. Other Concrete Structures above ground	5.0

6 METHOD OF ANALYSIS

The acceleration response spectra included in Appendix 2I will be used for the design of Class I and II structures, components, and systems. The vertical component of ground motion is assumed to be 2/3 of the horizontal component. The respective vertical and horizontal seismic components at 1
any point on the shell will be added by summing linearly and directly the 4
absolute values of the response (i.e., stress, shear, moment, or deflection) of each contributing frequency due to vertical motion and adding the resultants to the corresponding absolute values of the response of each contributing frequency due to horizontal motion.

For Class I structures, components, and systems the method of analysis will either be a modal analysis wherein modal shapes, frequencies, stresses, and proportionality factors are determined or will be performed as follows:

a. The natural period of vibration of the structure, component, or system will be determined.

b. The response acceleration of the component to the seismic motion will be taken from the response spectrum curve at the appropriate natural period.

c. Stresses and deflections resulting from the combined influence of normal loads and the additional load from the 0.05 g earthquake will be calculated and checked against the limits imposed by the design standard or code.

d. Stresses and deflections resulting from the combined influence of the normal loads and the additional loads from the 0.10 g earthquake will be calculated and checked to verify that deflections do not prevent functioning and that stresses do not produce rupture or excessive distortion.

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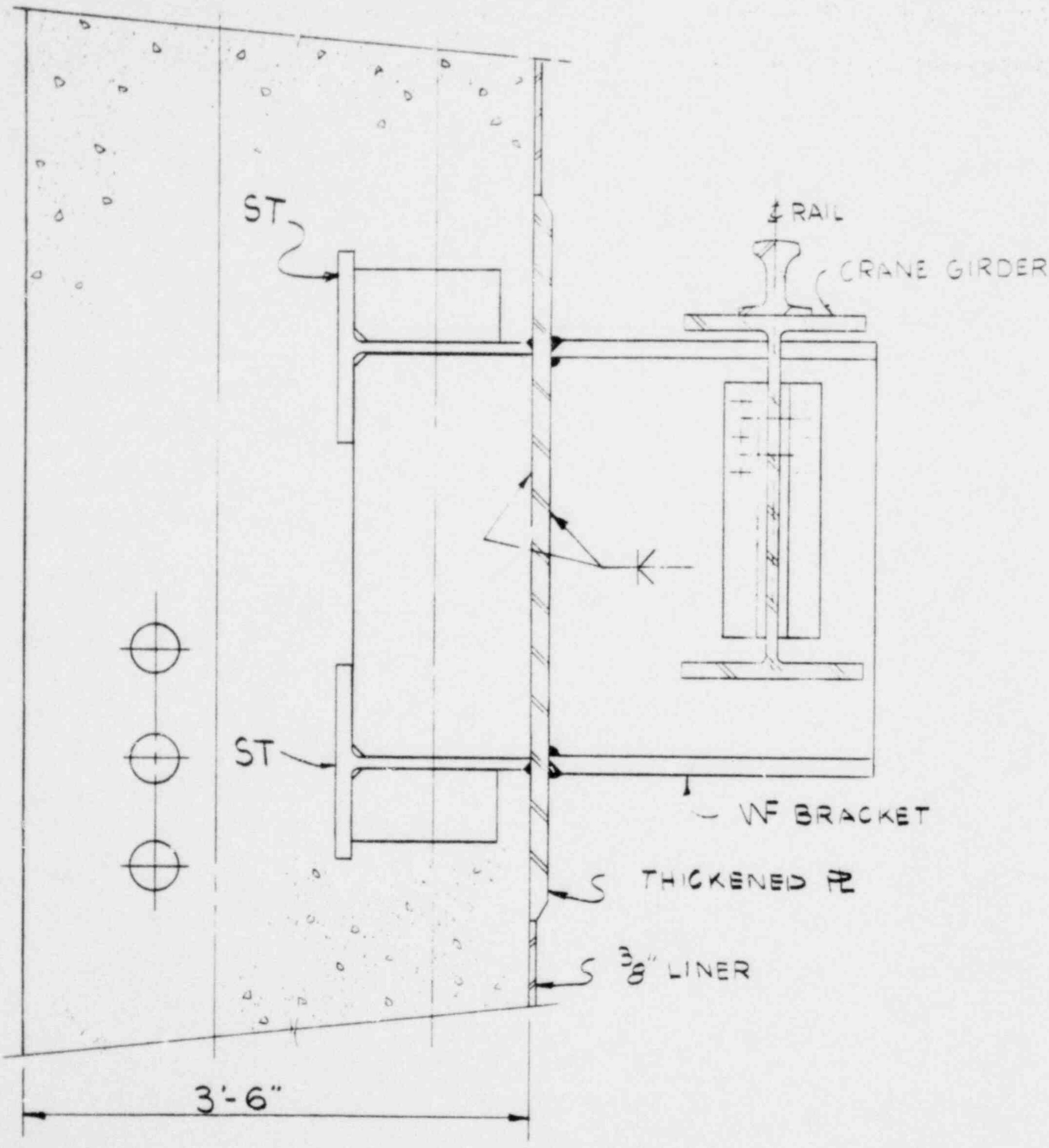
7 REFERENCES

a. Nuclear Reactors and Earthquakes, AEC Publication TID-7024.

b. Wind Forces on Structures, Task Committee on wind forces, ASCE Paper No. 3269.



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TYPICAL CRANE BRACKET DETAIL

CRYSTAL RIVER UNITS 3 & 4

FLORIDA POWER CORPORATION

FIGURE 5A - 1

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