APPENDIX 5E

LINER PLATE SPECIFICATION

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1.0 SCOPE OF WORK

1.1 GENERAL

The Reactor Building for each unit of the Crystal River Plant Units 3 and 4 of the Florida Power Corporation will be a steel lined concrete shell in the form of a vertical right cylinder with an ellipsoidal dome and flat base. The concrete thickness will be 3 ft 6 in. for the cylindrical walls and 3 ft for the dome.

The work to be performed under this contract shall include the furnishing, fabrication, delivery, unloading, storage as necessary, erection and testing of the steel liner and penetrations, complete, all as specified herein and/or as shown on the Drawings.

The Contractor shall be responsible for erecting a leak tight liner. The degree of leak tightness shall ensure a containment leak rate of no greater than 0.25 per cent by weight of contained air in 24 hours at 55 psig. The Contractor shall be fully responsible for designing liner reinforcement adequate to resist all erection loads including those additional erection loads specified herein excluding those erection loads resulting from using the liner as a form for concrete work. The Contractor shall also be responsible for properly fabricating a liner which will be an element of the composite steel and concrete shell. The structural design of the personnel locks and that portion of the equipment access door extending beyond the reinforced concrete shell shall be this Contractor's responsibility. Detailed design of remaining penetrations will be made in collaboration with the Engineer.

1.2 WORK INCLUDED

The work shall include but not necessarily be limited to the following:

a. Detailed design of:

1. All penetrations including electrical, mechanical, equipment and personnel access, and fuel transfer penetrations in collaboration with the Engineer based upon the parameters specified hereinafter and/or as shown on the Drawings, except that this Contractor shall be totally responsible for the structural design of the personnel locks and that portion of the equipment access door extending beyond the reinforced concrete shell.

2. Liner reinforcement about openings.

3. Reinforcement to resist all erection loads except concrete placement.

b. Preparation of shop details and erection drawings for the liner and penetrations.

c. Furnishing, fabricating, erecting, and testing the following:

1. Liner main shell including cylindrical walls, dome, and flat base.

2. One equipment access hatch with a minimum inside diameter of 18 ft 0 in.

3. Two personnel air locks with a minimum inside diameter of 8 ft 6 in. One of these personnel hatches shall be mounted in the equipment access hatch. The air lock in the equipment access hatch shall measure 15 ft from door to door. The personnel access air lock shall measure 9 ft from door to door. Doors shall be pressure seated type 3 ft 6 in. by 6 ft 8 in. and provision shall be made to test between doors at 55 psig.

4. Mechanical, electrical, and fuel transfer penetrations.

d. Performing all quality control measures and preliminary tests as specified hereinafter.

e. Painting the liner with one coat of primer except the underside of bottom plate which need not be painted.

f. Designing reinforcement and performing all work for required temporary access openings.

1.3 WORK NOT INCLUDED

Associated work not included under this contract is as follows:

a. Concrete work.

b. Furnishing or erecting backup bars embedded in the concrete base mat. Basement will be sloped for adequate drainage.

c. Finish painting of the liner.

2.0 DESIGN REQUIREMENTS

2.1 CODES AND REGULATIONS

Except as noted hereinafter, the selection of materials, details of fabrication, and workmanship shall conform to the requirements of the Nuclear Vessels Code for Class B Vessels. The containment liner and penetrations shall conform in all respects to the applicable sections of ASA N 6.2-1965, "Safety Standard for Design, Fabrication and Maintenance of Steel Containment Structures for Stationary Nuclear Power Reactors." The personnel locks,

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and that portion of the equipment access door extending beyond the reinforced concrete shell, shall conform in all respects to the requirements of the Nuclear Vessels Code for Code for Class B Vessels.

2.2 TECHNICAL PARAMETERS

The technical conditions applicable to the complete containment vessel are as follows:

Vessel inside diameter	130 ft
Tangent length	157 ft
Elipsoidal Dome: a) Short Radius	20.5 ft
b) Long Radius	110 ft
Design pressure	55 psig
Design temperature	281 F
Operating pressure, range	+1 to -1 psig
Operating temperature, range	
Inside Vessel	+90 to 110 F
Outside Vessel	+25 to 100 F
Design differential pressure	2.5 psi
Liner leak rate @ 55 psig	0.25%/24 hours

2.3 CYLINDER REINFORCEMENT

The outside walls shall be reinforced on the outside face so as to support the dead load of the liner plus erection, and wind.

2.4 OPENING REINFORCEMENT

The liner shall be reinforced about all openings in accordance with the Unfired Pressure Vessels Code (i.e., by replacing cut out area of 3.8 in. liner plate).

2.5 PLATE THICKNESS

The steel plate for the main shell including the cylindrical walls and the dome but excluding specially reinforced areas shall be 3/8 inches thick. The steel plate for the containment base liner including the pits and sumps shall be a minimum thickness of 1/4 inches.

2.6 ENGINEER'S REVIEW

The Contractor shall submit design calculations and detail drawings to the Engineer for review and record prior to initiating fabrication. Review and/or approval of information submitted to the Engineer shall not relieve the Contractor of any responsibility for design, fabrication, erection, and testing as herein specified.

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3.0 MATERIALS

3.1 MAIN SHELL

Steel plate for the main shell including the dome, cylindrical walls, and base shall conform to "Specification for Structural Steel (Tentative)," ASTM A 36-66T or to "Specification for Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality," ASTM A 283-63, Grade C. Rolled sections including test channels and stiffeners shall conform to "Specification for Structural Steel," ASTM A 36-66T.

3.2 PENETRATIONS

The materials for penetrations including the personnel and equipment access hatches as well as the mechanical and electrical penetrations shall conform with the requirements of the ASME Nuclear Vessels Code for Class "B" Vessels and shall exhibit ductility and welding characteristics compatible with the main shell material. The selection of materials for penetrations shall consider a lowest service metal temperature of 90 F within containment and 25 F outside containment.

All materials for penetrations shall exhibit impact properties as required for Class "B" Vessels. The materials for penetrations shall be carbon steel except as otherwise specified herein or shown on the Drawings.

4.0 WELDING

4.1 GENERAL

The qualification of welding procedures and welders shall be in accordance with Section IX "Welding Qualifications" of the ASME Boiler and Pressure Vessel Code. The repair of defective welds shall be in accordance with Paragraph N-528 of the ASME Nuclear Vessels Code. The Contractor shall submit welding procedures to the Engineer for review. Review and/or approval of procedures does not relieve the Contractor of welding responsibility.

4.2 QUALITY CONTROL

Longitudinal and circumferential welded joints within the main shell, the welded joint connecting the dome to the cylindrical side walls, and any welded joints within the dome shall be inspected by the liquid penetrant method and spot radiography, all as hereinafter specified. All penetrations including the equipment access door and the personnel locks shall be examined in accordance with the requirements of the ASME Nuclear Vessels Code for Class "B" Vessels. All other shop fabricated components including the reinforcement about openings shall be fully radiographed. All other joint details shall be examined by the liquid penetrant method.

Full radiography shall be in accordance with the procedure and governed by the acceptability standards of Paragraph N-624 of the ASME Nuclear Vessels Code. Spot radiography shall be in accordance with the procedures and governed by the acceptability standards of Paragraph UW-52 of the ASME Unfired Pressure Vessels Code.

Methods for liquid penetrant examination shall be in accordance with Appendix VIII of the ASME Unfired Pressure Vessels Code.

5.0 TEST CHANNELS

Steel channels shall be provided along all weld seams which will be inaccessible when all construction is completed. The channels shall be segmented so as to ensure no length of weld covered by any one channel segment exceeding the greatest dimension of one plate. One fitting shall be provided in each channel segment and shall extend through any covering material including concrete, and be plugged. The fittings on the base shall be protected by sleeves at the base weld to ensure no weld failure during placing of concrete. All test channels shall be located on the face of the liner inside containment. Steel angles shall also be installed to cover penetration sleeve to liner plate welds.

6.0 ERECTION TOLERANCES

Erection tolerances shall be as follows:

a. Overall out of roundness – ±3 in.

b. Deviation from round in 10 ft – 1-1/2 in. except at seams.

c. Overall deviation from a plumb line – ±3 in.

d. Deviation from line between tangent points – at cylinder to dome transition and base to cylinder transition – ±3 in.

e. Shell plate edges shall butt for a minimum of 75 per cent of wall thickness.

Tolerances for all penetrations shall be as specified under Section 7.2 of this Specification. These tolerances shall be maintained in the final erected position.

7.0 PENETRATION AND OPENINGS

7.1 EQUIPMENT AND PERSONNEL ACCESS HATCHES

The following shall apply to both the equipment and personnel openings in the containment liner:

a. All flanged joints shall be designed in such a manner that a double gasketed seal can be employed as a seal. This seal shall be capable of being pressurized between seals to 55 psig during accident conditions.

b. The material used in the construction of the openings shall be compatible with the liner material metallurgical characteristics.

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c. The personnel opening doors shall be interlocked to prevent both being opened simultaneously. Interlocks shall be so connected that one door must be completely closed before the opposite door can be opened.

d. For the personnel openings, remote indication shall be provided to show position of the interlock mechanisms and the far door.

e. Provisions in personnel locks shall be provided to accommodate an interior lighting system provided by the Owner, which will be capable of operating from the Owner's emergency power supply.

f. Provisions in personnel locks shall be provided to accommodate an emergency communication system provided by the Owner.

g. Provisions on personnel locks shall be provided to permit bypassing the door interlocking system to allow doors to be left open when plant is shutdown.

h. The floor system of the personnel locks shall be designed so that they can be easily removed.

i. The personnel locks shall be designed, fabricated, tested, and stamped in accordance with the ASME Nuclear Vessels Code as Class "B" Vessels.

j. The personnel locks shall be designed to be capable of testing to 63.3 psig in the interspace between doors.

k. All personnel lock hinges shall be capable of a three-dimensional adjustment to assist proper seating. Hinges shall be capable of independent adjustment.

l. All seals, gaskets, O-rings, or other seating materials shall be suitable to withstand design temperature conditions.

m. Personnel lock equalizing valves shall be of the quick-acting type.

n. Vendor shall quote as an alternate extra design, fabrication, and attaching supports complete with wheels for the removable section of the equipment hatch. Provisions for jack screws for leveling shall also be provided.

7.2 MECHANICAL PENETRATION

The following shall apply to the fabrication and testing of all penetrations:

a. Details for mechanical penetrations shall be as shown on design drawings.

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b. For bidding purposes provision shall be made for a minimum of 1/4 in. axial movement of all pipes inserted into penetrations. Expansion requirements shall be as shown on design drawings.

c. The penetration material shall be compatible with liner materials.

d. Where thermal insulation is required, means shall be provided to protect against chloride stress corrosion. Specification for insulation shall be submitted to the Engineer for review and comment.

e. All pipe insertions shall be Schedule 80 except as noted on the "Penetration List" or subsequent lists.

f. All bellows, expansion joints, gaskets, canopies, protectors, or other flexible member to be designed for a minimum of 250 cycles for the movement associated with each penetration.

g. The locations of penetrations with regard to azimuth location shall be within ±1/2 in. measured on the circular section. The horizontal and vertical dimensions associated with the radial dimension shall be ±1/2 in. for all pipe lines.

h. All penetrations shall be installed in the respective plate sections prior to testing.

i. All mechanical penetrations shall have double barriers designed for pressurization with air to 55 psig for leak testing.

7.3 ELECTRICAL PENETRATIONS

All electrical penetrations shall be designed as follows:

a. Penetration cartridges shall be supplied and installed in the penetration sleeves by the Contractor.

b. The penetration sleeves to accommodate the aforementioned cartridges shall be 10 in., Schedule 80 carbon steel pipe. Penetration sleeves shall be shop welded to the liner plate. Sleeves shall be equipped with standard 150 lb steel flanges, which shall be supplied with special compressible stainless steel high pressure seals and shall be drilled with two 1/4 in. pressurization paths to weld canopies.

c. Flange mating surfaces shall have RMS No. 63 finish.

d. All electrical penetrations shall be supplied with blind flanges. Blind flanges shall have grooves for double O-ring seals, and one drilled pipe connection, no greater than 1/4 in. for pressurization. Dual pressurization paths shall be provided for canopy testing.

e. The supplier of the penetration cartridges will supply the compressible stainless steel high pressure seals.

f. The weight of the liner cartridges will not exceed 250 lbs.

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g. All joints and pressurization paths shall be designed to be pressurized with air to 55 psig. All joints shall be soap bubble tested and freon sniff tested in the same manner as noted under Section 7.4 of this Specification.

7.4 PENETRATION SHOP TESTING - MECHANICAL AND ELECTRICAL

The following tests shall be applied to all penetrations:

a. A proof test shall be applied to each penetration which will pressurize the penetration annulus to 63.3 psig. The pressure shall be reduced to 55 psig and held at this pressure to soap bubble and sniff test all welds and mated surfaces. If leaks are found, they shall be repaired and retested; this procedure shall be followed until no leaks exist. Tests to be conducted in accordance with Section 7.4, b of this Specification.

b. Local tests are to be conducted in accordance with "Proposed Standard for Leak Rate Testing of Containment Structures for Nuclear Reactors," ANS 7.60, Appendix A.

c. Purchaser reserves the right to witness shop tests and shall be notified at least two weeks in advance of all shop tests.

7.5 PENETRATION APPURTENANCES

The following shall apply to all penetrations:

a. Reinforcing shall be designed to support penetration in liner for shop testing, shipping, and field erection.

b. All bellows shall be fabricated from stainless steel having metallurgical characteristics compatible with mechanical design requirements. Bellows are to be suitably protected against field damage and will remain as part of the permanent installation.

7.6 SPECIAL PENETRATIONS

Two penetrations requiring special attention are the "Containment Supply and Exhaust Purge Ducts" noted in the Penetration List. The following additional requirements are imposed on these penetrations:

a. Formed heads shall be supplied with the penetration and shall be suitable for use during liner tests.

b. Each penetration shall be provided with two test connections of not less than 1/4 in. pipe size, to test both pipe and annulus spaces.

c. Mechanical spares as so designated in the Penetration List, shall have both ends of the sleeves capped. The outside cap (concrete side) shall be equipped with a test connection no less than 1/4

in. pipe size. Unless otherwise stated, all spare sleeves shall be 10 inch diameter, schedule 80 pipe.

7.7 FUEL TRANSFER PENETRATION

The fuel penetration shall be as detailed on the Drawings. The pipe insertion will be supplied by others. The tolerance on location and orientation shall be as shown on the Drawings.

8.0 PRELIMINARY TESTS

All testing as hereinafter described shall be performed by this Contractor. These tests shall include the following:

a. All weld seams on the base, pits, and between penetration sleeves and liner plate, and any additional weld seams which are covered by steel test channels shall be examined by detecting leaks at 55 psig using a mixture of air and freon. For the freon test, all exposed seams shall be checked with a halogen leak detector and 100 per cent of detectable leaks corrected. The tests on welds shall be conducted in accordance with those set forth in Section 7.4 of this Specification.

b. All weld seams not covered with test channels shall be tested using a soap film and vacuum box. The pressure differential shall not be less than 4 psig. The rate of inspection shall not exceed two feet of weld per minute. The box shall overlap a minimum of six inches over the previously tested section. All detectable leaks shall be corrected.

c. Embedded test connections shall bear metal stamped identification tags firmly affixed and referenced on drawings to test channel section to which it is attached. All other test connections will be dimensioned on "as built" drawings. Any field changes will be subject to Engineer's approval and shall be kept current and revised drawings issued at completion of erection.

d. The Contractor shall provide adequate documentation for all tests and submit copies of such documentation in triplicate.

9.0 PAINTING

The steel surfaces shall be cleaned as specified in either SSPC-SP 6-63 "Commercial Blast Cleaning," or SSPC-SP 8-63, "Pickling" except that the pickling procedure shall be modified as specified hereinafter. The pickling procedure shall consist of immersion of steel surfaces in 5 to 10 per cent sulfuric acid solution at 160 F to 180 F to remove rust and mill scale. The steel shall be thoroughly rinsed with fresh water. Precautions include elimination of any phosphate treatment or alkali treatment which may be used for hot dip galvanizing. The acid bath shall be periodically regenerated to control black smut contamination, and the fresh water bath shall be continuously regenerated.

As soon as practicable after the steel is cleaned, all interior surfaces of the cylinder and dome, except prepared edges that must be field welded, shall be sprayed with one coat of Carbozinc #11 Gray as manufactured by the Carboline Company. The dry film thickness of the paint at any point shall not be less than 2.5 mils. After field erection the unpainted surfaces and any surfaces which have been damaged during shipment or erection shall be cleaned in accordance with SSPC-SP 6-63 or as otherwise approved by the paint manufacturer and shall be coated as hereinbefore specified. All Carbozinc #11 shall be applied in accordance with the manufacturer's printed instructions.

As soon as practicable after the steel is cleaned, all surfaces except the interior of the cylinder and dome, the underside of the base liner, and prepared edges that must be field welded shall be primed with one coat of paint conforming with Federal Specification TT-P-645A, "Primer, Zinc Chromate Alkyd."

The dry film thickness of the paint at any point shall not be less than 1.5 mils. After field erection the unpainted surfaces and any surface which have been damaged during shipment or erecting shall be cleaned in accordance with SSPC-SP 3-63 "Power Tool Cleaning" and primed as hereinbefore specified. All paint shall be applied in accordance with SSPC-PA 1-64, "Shop, Field and Maintenance Painting."

10.0 MATERIAL DAMAGES

All materials shall be carefully handled so that members or parts which have become damaged since fabrication shall be straightened by methods which will not produce fracture or other injury, and without heating unless approved in writing by the Engineer. Any members which are so damaged that it is inadvisable to correct them in the field shall be replaced with new members. Hammering which will injure or distort the members will not be permitted.

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