TVA

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J. L. Wilson
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March 27, 1992

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328

SEQUOYAH NUCLEAR PLANT (SQN) - ICE CONDENSER LOWER PLENUM FLOOR MOVEMENT AND DEGRADATION

Reference: Letter from Stewart D. Ebneter to TVA, Attn: Mr. J. R. Bynum, dated March 23, 1992, "Confirmation of Action Letter"

This letter provides the information requested under Items 1, 2, and 3 in the referenced letter regarding the subject issue. The information provided by this submittal will be discussed in the NRC meeting scheduled for 11 a.m., on April 3, 1992, in the NRC Region II offices. This meeting will complete Item 4 of the referenced letter.

TVA has identified upward movement and cracking of the Units 1 and 2 ice condenser floor wear slabs that form the top layer of the ice condenser floor assembly. This upward movement also resulted in mechanical interference with the bottom of a number of lower ice condenser inlet doors, thereby increasing the required opening force beyond the technical specification (TS) limit of 675 inch-pounds. The condition was discovered during inspections of the lower inlet doors during the Unit 2 Cycle 5 refueling outage on March 16, 1992, and verified on March 17, 1992, following further engineering inspection and review. Movement of 27 of 48 doors was found to be inhibited, along with localized wear slab cracking and upward displacements of up to several inches. The immediate apparent cause of the wear slab degradation was water intrusion, freezing, and expansion within the floor assembly. Confirmatory inspection of Unit 1 on March 18, 1992, which was operating near 100 percent power three months into Cycle 6 operation, identified similar indications, although to a lesser extent, affecting 11 of 48 doors. TVA conducted an orderly shutdown of Unit 1 to effect resolution to the observed problems, and hot standby was reached at 0247 Eastern standard time on March 19, 1992.

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TVA has taken short-term actions to establish or verify operability of the Unit 1 ice condenser and to bound the effects of the condition for that unit under power operation. The doors have be-- estored operable, the current configuration has been determined acceptable from both systems and structural performance standpoints, and an at-power monitoring plan has been established to verify continued operability. Evaluations supporting these efforts have been reviewed by the onsite Plant Operations Review Committee, an indepeudent structural consultant, ice condenser uesigner, and a system specialist from Westinghouse Electric Corporation.

Additional actions have been taken to prevent further degradation of Unit 2 during the ongoing outage maintenance activities and are being taken to establish or verify the operability of ice condenser systems, structures, and components before Unit 2 start-up from the outage. Additional parallel investigation and corrective efforts are also ongoing. It is expected that the resultant modifications and/or repairs implemented for Unit 2 during this outage will constitute permanent long-term corrective actions. However, at-power monitoring will be conducted to verify the effectiveness of those actions and to determine the optimum long-term actions for Unit 1.

TVA considers that the actions taken and planned provide assurance that the SQN ice condensers will remain capable of performing the intended accident mitigation function and that the causes of the condition are being addressed to prevent future recurrence.

Details concerning TVA's evaluation and corrective actions are provided in Enclosure 1. Supporting documentation and evaluations for Unit 1 have been provided to the onsite resident inspectors and are referenced in Enclosure 1. Commitments made in this submittal are listed in Enclosure 2. Please direct questions concerning this issue to M. A. Cooper at (615) 843-8422.

Sincerely,

J. L. Wilson

Enclosures
cc: See page 3

cc (Enclosures):

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ENCLOSURE 1

ICE CONDENSER LOWER PLENUM FLOOR
MOVEMENT AND DEGRADATION

ENCLOSURE 1

I. BACKGROUND

A. Design Description

The Sequoyah Nuclear Plant (SQN) containments are an ice condenser pressure suppression design. The internal design pressure for the containment is 12 pounds per square inch gauge (psig), and the design temperature is 250 degrees Fahrenheit (F). The primary containment structure is a freestanding welded steel structure with a vertical cylinder, hemispherical dome, and a flat circular base. The internal concrete structural design allows the containment to be divided into four main areas for containment pressure design evaluation: the lower compartment, the dead-ended compartment, the upper compartment, and the ice condenser (see Attachments 1 and 2 for containment and ice condenser sections). The ice condenser is a passive device containing borated ice that is utilized in the event of a loss-of-coolant accident (LOCA) or high-energy link break (HELB) to absorb thermal energy. This ensures that steam is condensed and the pressure energy is reduced to ensure containment integrity in the early stages of an accident. During a postulated LOCA or HELB, which can only occur in the lower compartment, steam emanating from the break location, along with the normal atmosphere of the lower compartment, is directed almost exclusively to the ice condenser section via pressure-driven flow through the lower ice doors.

These lower ice doors, which are held closed during normal operation by the cold air head pressure occurring inside the ice condenser, are designed to open at a differential pressure of 1 pound per square foot (psf). After entering the ice condenser, the steam and/or air mixture is directed upward toward the ice bed where the ice removes energy from the mixture, resulting in the condensing of the steam, cooling of the air, and melting of a portion of the ice. Discharge from the ice condenser is made to the upper compartment where continued cooling is ensured by operation of the containment spray system. This flow pattern is maintained by the pressure-driven blowdown forces until the end of the blowdown period. After this initial blowdown phase, the continued movement of the steam and/or air mixture is ensured by the air return fan system that forcibly returns the changing atmosphere in the upper compartment to the lower compartment region by the way of the dead-ended compartment.

The ice condenser is divided into 24 bays, with each bay having a pair of inlet doors in the lower plenum (see Attachments 3 and 4 for the lower elevation door and plan views). These door panels are provided with tension spring mechanisms that produce a small closing torque on the door panels as they open. The magnitude of the closing torque is equivalent to providing approximately 1-psf pressure drop through the inlet ports with the doors open to a position equivalent to the full port flow area. The zero load position of the spring mechanisms is such that, with zero differential pressure across the door panels, the gasket holds the door slightly open. The setting provides assurance that all doors will be open slightly, upon removal of cold air head, therefore eliminating significant inlet maldistribution for very small incidents. For larger incidents, the doors open fully and flow distribution is controlled by the flow area and pressure drops of inlet ports. The doors are provided with shock absorber assemblies to dissipate the large door kinetic energies generated during large break incidents.

The ice condenser floor assembly consists of an 18-inch-thick structural slab, spanning between the crane wall and concrete columns at the steel containment vessel (SCV) (see Attachment 5 for the floor assembly details). A vapor barrier (copper armored sisalkraft) is installed on top of the structural slab, with a 15-inch-thick foam concrete layer poured as an insulator. The foam concrete is a very light-weight concrete consisting of portland cement, water, and a foaming agent. On top of the foam concrete, a 1-inch-thick layer of grout was placed to provide a level surface for the placement of a 1/4-inch steel plate that has the glycol piping attached to it. Within each bay, the steel plate consists of two pieces that were "butted" together and spliced with a plate on the top. The splice plate was tack welded to the two bottom plates. The 4-inch concrete wear slab is poured on the top of the steel plate. Reinforcing steel at 6 inches on center in both the radial and circumferential direction was placed with 1/2 inch cover from the top of the slab. Each bay of the wear slab is independent of the next bay and separated with expansion joints. The wear slab is also independent of the crane wall with an expansion joint occurring at the juncture of the crane wall and wear slab. The design required that the expansion joints be sealed with a sealer 1/2 inch deep.

B. Identified Condition

Upward movement and cracking of the wear slabs were identified in both SQN Units 1 and 2. The cracking is located principally near points of rigid restraint. This upward movement also resulted in mechanical interference with the bottom frames of a number of lower inlet doors, thereby increasing the required opening force beyond the technical specification (TS) limit of 675 inch-pounds. The condition was discovered of the lower inlet doors during the Unit 2 Cycle 5 refueling outage inspections on March 16, 1992, and verified on March 17, 1992, following further engineering inspection and review. The movement of 27 of 48 doors was found to be inhibited, along with localized wear slab cracking and upward displacements of up to several inches. The immediate apparent cause of the wear slab degradation was water intrusion, freezing, and expansion within the floor assembly. A confirmatory inspection of Unit 1 on March 18, 1992, which was operating near 100 percent power three months into Cycle 6 operation, identified similar indications, although to a lesser extent, affecting 11 of 48 doors. TVA conducted an orderly shutdown of Unit 1 to effect resolution to the observed problems, and hot standby was reached at 0247 Eastern standard time on March 19, 1992. The condition resulted in potential operability impacts of the ice condenser from both performance and structural standpoints.

TVA has concluded that the wear slab movement and degradation resulted from water intrusion, freezing, and expansion within the floor assembly. Several paths for floor assembly water intrusion were created by initial construction and design deficiencies. A design change during construction and approved by Westinghouse allowed the removal of the requirement for a sealed metal flashing at the crane wall expansion joint and for elimination of the expansion joint and sealant over two short sides of the middle column support. Additionally, walkdowns have determined that the sealer in the expansion joints, which is required by the designer, is "missing" in several areas. It was also found that the steel plates were warped in some cases at the time of initial installation and were installed on cured hardened grout, leading to gaps within the floor assembly. Subsequent maintenance practices resulted in significant exposure to water during outage maintenance activities (e.g., defrosting and cleaning) and did not establish appropriate controls to prevent water from accumulating or standing on the floor and in the drains during those maintenance activities. Additionally, humid, lower-containment air present in the floor drains during operation would provide a mechanism for condensation and freezing within available gaps and passages.

The combination of installed conditions and maintenance practices could create cycles of water intrusion, freezing, and expansion over time that would create progressively larger passages for future intrusion leading to the observed condition. Through inspection and evaluation, it is believed that the ice largely exists in passages beneath the steel plate. The foam concrete shows no evidence of movement. In summary, TVA concludes that the cause of the condition is the combination of the installed configuration deficiencies and maintenance practices described above. Further details concerning this assessment will be documented in the ongoing incident investigation (Reference 5).

TVA has established and is implementing a comprehensive corrective action plan to address identified ice condenser, lower-plenum floor movement and degradation for both Units 1 and 2. This plan includes immediate actions necessary to return Unit 1 to operation (Section II), short-term actions to address the ongoing Unit 2 outage activities and its subsequent return to power operation (Section III), and longer-term monitoring to assess effectiveness of the actions taken and to confirm the optimum long-term resolution for Unit 1 (Section IV). Details concerning each of these areas are addressed below.

II. IMMEDIATE ACTIONS - UNIT 1 RESTART ACCEPTABILITY BASIS

Unit 1 was operating near 100 percent power, approximately three months into the Cycle 6 operation, at the time of discovery of applicability on that unit. TVA concluded that neither the SQN ice condenser door TS (LCO 3.6.5.3) nor the ice bed TS (LCO 3.6.5.1) appropriately addressed the existing condition and that the as-found condition warranted unit shutdown. Accordingly, an orderly shutdown was initiated. Continued operability of the ice condenser must be verified and/or established before restart.

To restore operability to the Unit 1 lower inlet doors, a temporary modification (Reference 1) was performed to remove the lower "L-shaped" sheetmetal flashing and gasket mounted on the wear slab and connected to the flashing piece that forms the jam for the lower inlet doors. This removed the interference with the bottom of the doors and provided physical margin for wear slab growth without interference with the doors. A second temporary modification was implemented to replace the insulation bags installed under the flashing with a double layer of Armaflex rubber insulation fixed in place with adhesive. This provided improved sealing of air-leakage paths and ensured retention under accident conditions. Refer to Attachment 6 for the premodification and postmodification configurations. Following removal of the flashing and gasket described above, a pull-force surveillance test was successfully performed for all of the Unit 1 lower inlet doors, verifying TS operability. The removal of the flashing and gasket provides acceptable configuration during power operation, but would require further alteration to support future outage maintenance activities. As discussed in Sections III and IV, the long-term overall resolution and configuration for Unit 1 will be determined from the ongoing resolution for Unit 2 and subsequent monitoring of the effectiveness of those actions.

In parallel with the door activities, detailed walkdowns and inspections were performed to identify and assess impacts on interfacing components and to establish the baseline configuration for future monitoring. Specifically, a generalized walkdown and review of both the lower plenum area and the lower elevation below the ice condenser floor were performed to look for cracks, spalling, or other signs of distress. Floor assembly components and structural members were reviewed for corrosion and obvious deformation. Various interfacing features (e.g., conduit) were evaluated for signs of distress or damage because of the slab movements. The turning vanes were inspected to assess if the floor had displaced to the point of contact with the vanes, if the bolting was deformed, and if the wear slab in contact with the vanes was cracked. Visual observations, review of configuration, and operating history were performed for the glycol floor piping to identify any evidence of damage and operational impacts. The 12-inch floor drains were inspected for deformation, and sealing joints were inspected for damage and consistency with the as-designed configuration.

In conjunction with the direct visual examinations, a boroscope was utilized to verify the absence of indications of excessive corrosion on the SCV in the vicinity of affected ice condenser components. A boroscope was similarly utilized to inspect the exposed, interior floor assembly passages of the floor drain for assessment of ice formation extent and location; results of that inspection are available on tape. A detailed elevation survey and crack mapping of the wear slab were performed to document the present configuration.

From the above inspections, a 50.59 safety evaluation utilizing bounding evaluations (Reference 2) was performed that verified the structural integrity of components necessary to ensure functional capability of the ice condenser system and acceptability of the existing configuration relative to ice condenser operability. The structural slab evaluation consisted of the inspection described above, which did not identify any apparent cracking or areas of distress as well as potential downward loading on the structural slab prior to wear slab cracking and loading transmitted from wear slab and turning vane contact. The potential impacts were determined to be acceptable relative to design loading and capacities. The dead weight impact of water and/or ice within the floor assembly was determined to be minimal. Wear slab evaluation concluded that the slab would maintain position during a seismic condition and that the existing deformation did not prevent it from protecting the glycol piping. No evidence of glycol piping damage was identified through conducted inspections and a review of ice condenser or glycol temperatures. Upward loads transmitted by the wear slab on column anchor bolts were also evaluated; expansion joints prevent any loading on the columns themselves. Potential impact on bolt capacity was found to be insignificant. Conservative bounding evaluation of potential loading on the turning vanes and associated bolting concluded that functionality would be maintained.

To ensure that any potential further degradation does not impact operability, a periodic monitoring plan has been established (Reference 3) that will consist of at-power monitoring of floor movement every other day for the first week, once a week for the next month, and once a month thereafter if no observed changes are identified. Evaluation of monitoring results will determine appropriate changes in inspection scope or frequency. Several options are provided to minimize the as low as reasonably achievable impacts, including remote or upper containment monitoring of wear slab displacement transducers for each bay or utilization of a camera projected through the ice passages from the upper plenum for visual observation. Lower plenum entry for inspection is provided as a backup method. The monitoring instruction provides criteria for assessing inlet door operability impacts and conducting further engineering assessment to ensure the continued validity of the above-described evaluation.

Formal operational guidance (Reference 4) was established based on the ice condenser door TSs from Duke Power and the ongoing Methodically Engineered Restructured and Improved Technical Specifications effort. This guidance will remain in place to address any future identified impairments to inlet door performance until a formal TS amendment is submitted and approved.

The evaluations supporting the above-described actions were reviewed by the onsite safety review committee, the SQN Plant Operations Review Committee. The overall evaluation was reviewed by the ice condenser designer and system performance specialist from Westinghouse. The supporting structural evaluation was reviewed by an independent structural specialist.

A detailed final inspection to verify appropriate work closeout, material configuration, and area housekeeping will be conducted before entering Mode 4.

TVA considers that the above-described actions have bounded the effects of the subject condition and established appropriate basis for verifying continued ice condenser operability of Unit 1 over the remaining Cycle 6 operation.

III. SHORT-TERM ACTIONS - UNIT 2 RESTART ACCEPTABILITY BASIS

Additional short-term actions have been or are being taken to address resolution for Unit 2 and direct, long-term resolution and recurrence controls for both units. These actions can be broken into three categories: (1) actions to address ongoing Unit 2 outage maintenance activities, (2) actions to establish configuration acceptability of Unit 2 for restart from the outage, and (3) ongoing investigation efforts to establish long-term hardware and operational and/or maintenance improvements. It is expected that the long-term hardware modifications and/or repairs .l be implemented on Unit 2 before restart from the ongoing outage.

Upon identification of the condition, scheduled ice condenser outage activities for Unit 2 were placed on hold to allow for detailed inspections of the as-found condition similar to those conducted for Unit 1, and to establish additional controls to prevent further possible damage during the upcoming maintenance activities. Inspections and mapping have been completed as performed for Unit 1, and a detailed wear slab elevation survey and SCV inspection will be completed before restart. No observed distress or damage was identified on the structural slab. Limited as-found pull data for the inlet doors was obtained, limited by potential for damage to the more severely affected doors. A full structural and performance evaluation will be performed for Unit 2 similar to that performed for Unit 1 and will receive the same level of reviews for acceptability.

A detailed change analysis is being performed to better establish the relative contributions of the currently identified causes and contributing factors and to allow optimization of long-term actions relative to the material condition and operation and/or maintenance practices. This analysis includes the historical conditions and practices experienced at the SQN units, obtained from interviews and reviews of procedures and surveillance and inspection results. Differences between the SQN units and the other Westinghouse ice condenser units are also being evaluated in detail from design, construction, operation, and maintenance standpoints; initial review indicates similar design features but dissimilar maintenance practices.

The planned outage activities were evaluated for potential impact, specifically directed at activities that would expose the floor assembly to additional water intrusion, such as the floor and wall panel defrosting activities. The floor drains have been inspected and cleaned to provide free flow of any water accumulation. The defrosting maintenance practices have been revised to include additional controls and provisions to minimize water accumulation on the floor. Operational procedures are also being examined to effect improvement, e.g., glycol outage control and restoration.

To restore operability of the inlet doors, a modification will be implemented to install a sheetmetal flashing configuration that will allow for vertical movement. This will provide a long-term configuration that is acceptable from both operation and maintenance perspectives.

An additional modification will be implemented before start-up to seal exposed wear slab interfaces and joints at water intrusion paths, and to seal wear slab cracks as appropriate. Possible methods to drain water and/or ice accumulation from the floor assembly are being evaluated. Voids and separation in the floor drains will also be repaired as appropriate.

On-line monitoring of Unit 2 will be performed as previously described for Unit 1 to verify continued ice condenser operability and assess the effectiveness of the described actions.

In summary, these short-term activities are intended to ensure continued capability of the Unit 2 ice condenser to perform the required accident mitigation function and provide additional basis from which to establish long-term resolution for both units.

IV. LONG-TERM ACTIONS - UNITS 1 AND 2

Continued at-power monitoring during Cycle 6 operation and inspections conducted during the Cycle 6 refueling outages will be used to assess the effectiveness of actions previously taken and to establish the optimum long-term resolution for Unit 1.

TVA also plans to submit a permanent TS license amendment to provide appropriate action statement(s) for impairments to the opening capability of the ice condenser doors. Current in-process analyses (Reference 6) indicate that some level of impairment may be found acceptable; the results of these analyses will be addressed in the associated licensee event report to be issued by April 15, 1992. Until the final TS amendment is developed, submitted, and approved, prudent operational guidance will be provided through TVA's technical specification interpretation (TSI) process.

V. REFERENCES:

1. Temporary Alteration Change Form (TACF) 1-92-014-061, Revision 0 (R0), and Safety Evaluation, B38 920323 800
2. TACF 1-92-016-061, R0
3. Periodic Instruction (PI) 0-PI-SXX-061-001.0, "Ice Condenser Lower Plenum Floor Monitoring," and TACF 1-92-0017-061
4. TSI 92-01
5. Incident Investigation - .1-S-92-026 (unissued)
6. Operational Evaluation of the Binding of Lower Ice Condenser Doors in SQN Unit 1

Attachment 1

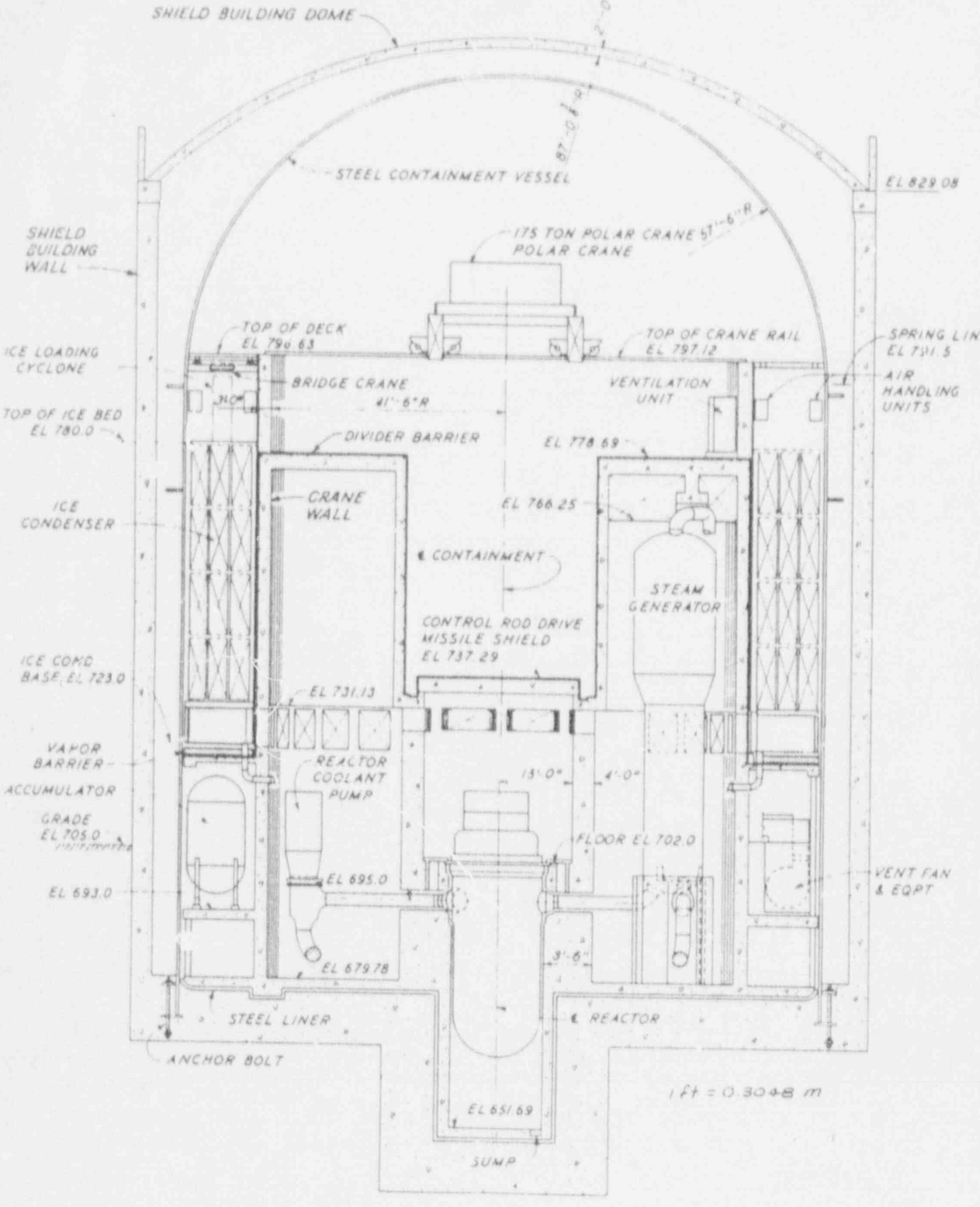


Figure 3.8.1-1 Reactor Building Elevation

ice condenser

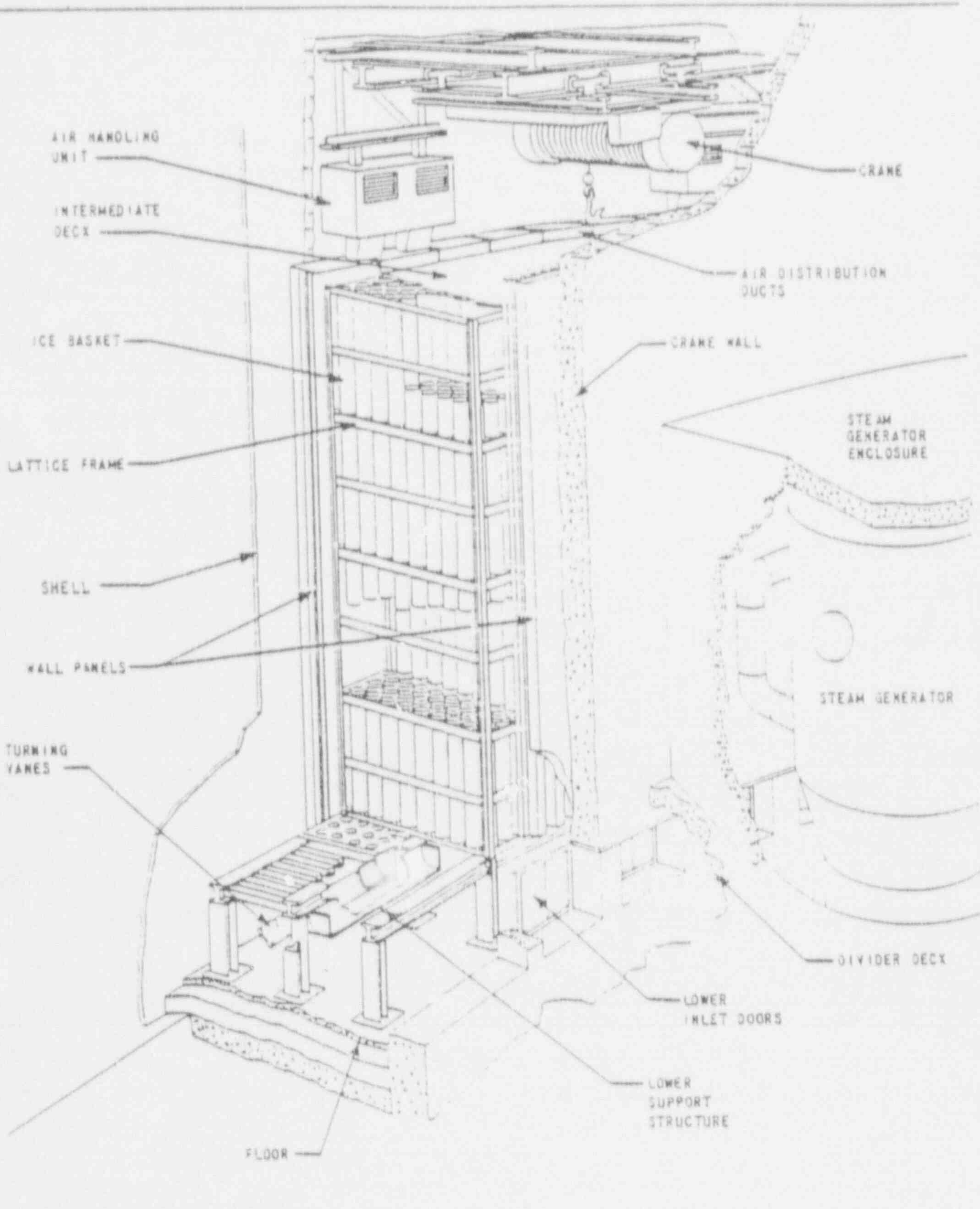
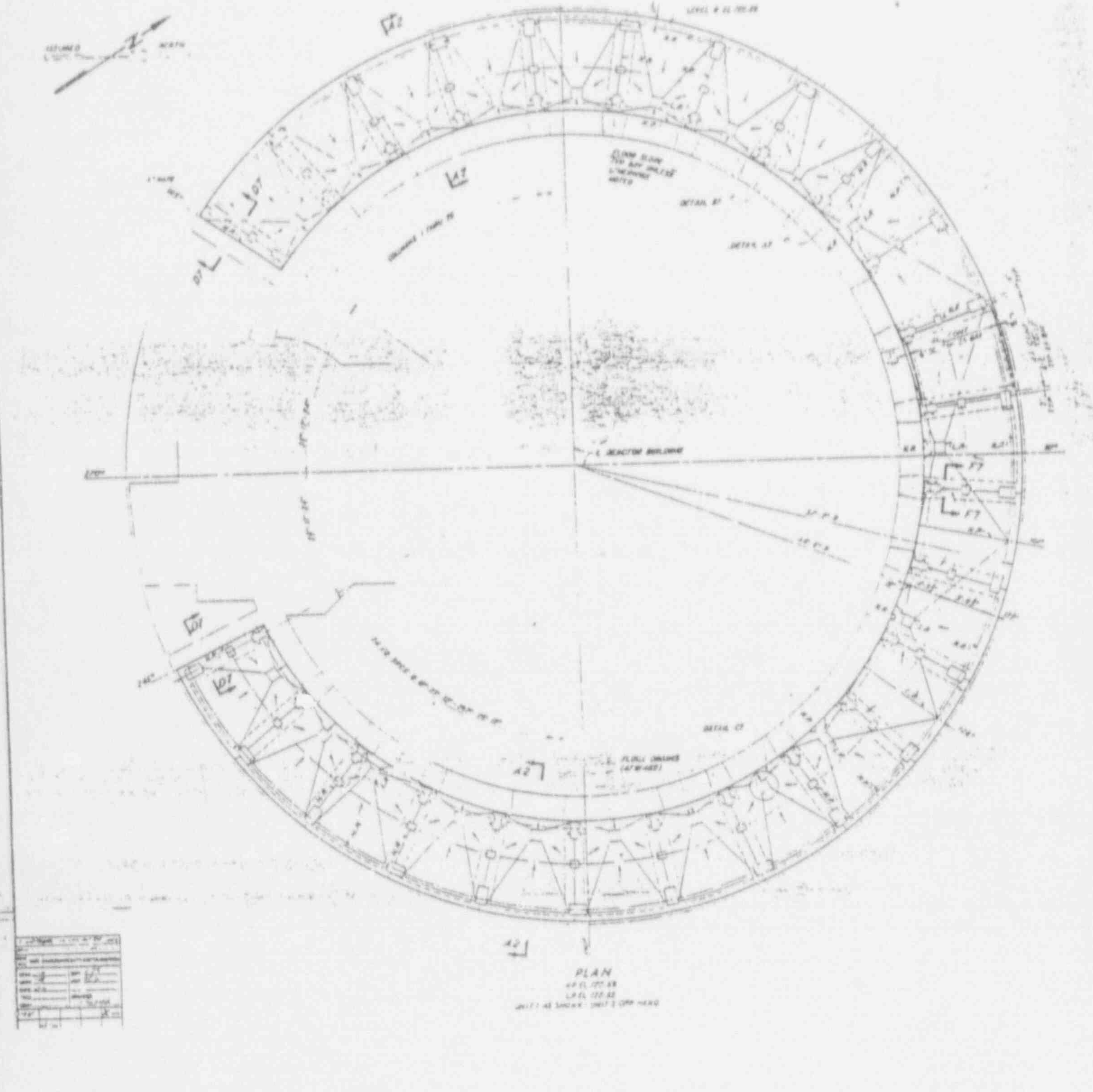


Figure 6.5.1-1 Isometric Of Ice Condenser

Attachment 3



Attachment 4

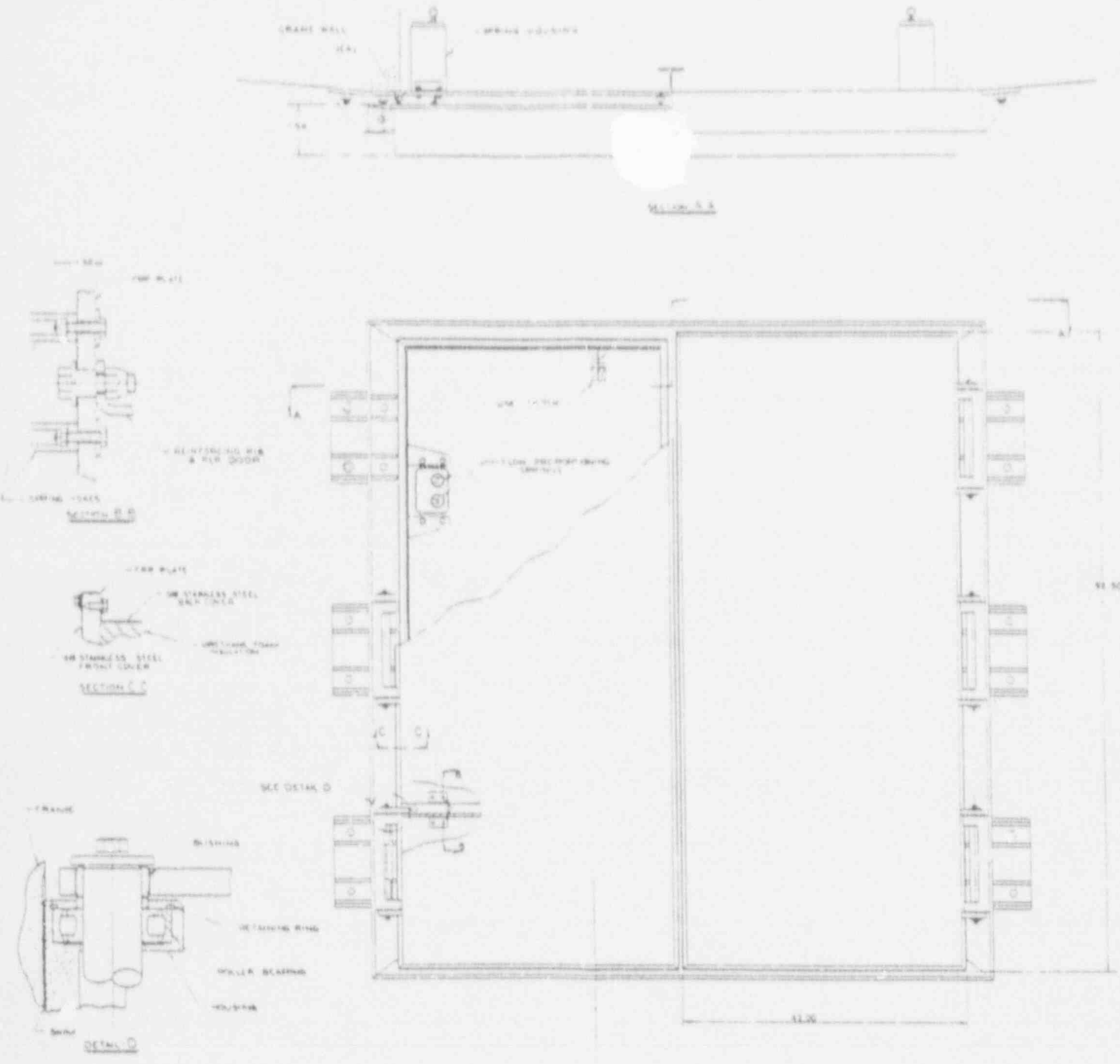


Figure 6.5.9-2 Lower Inlet Door Assembly

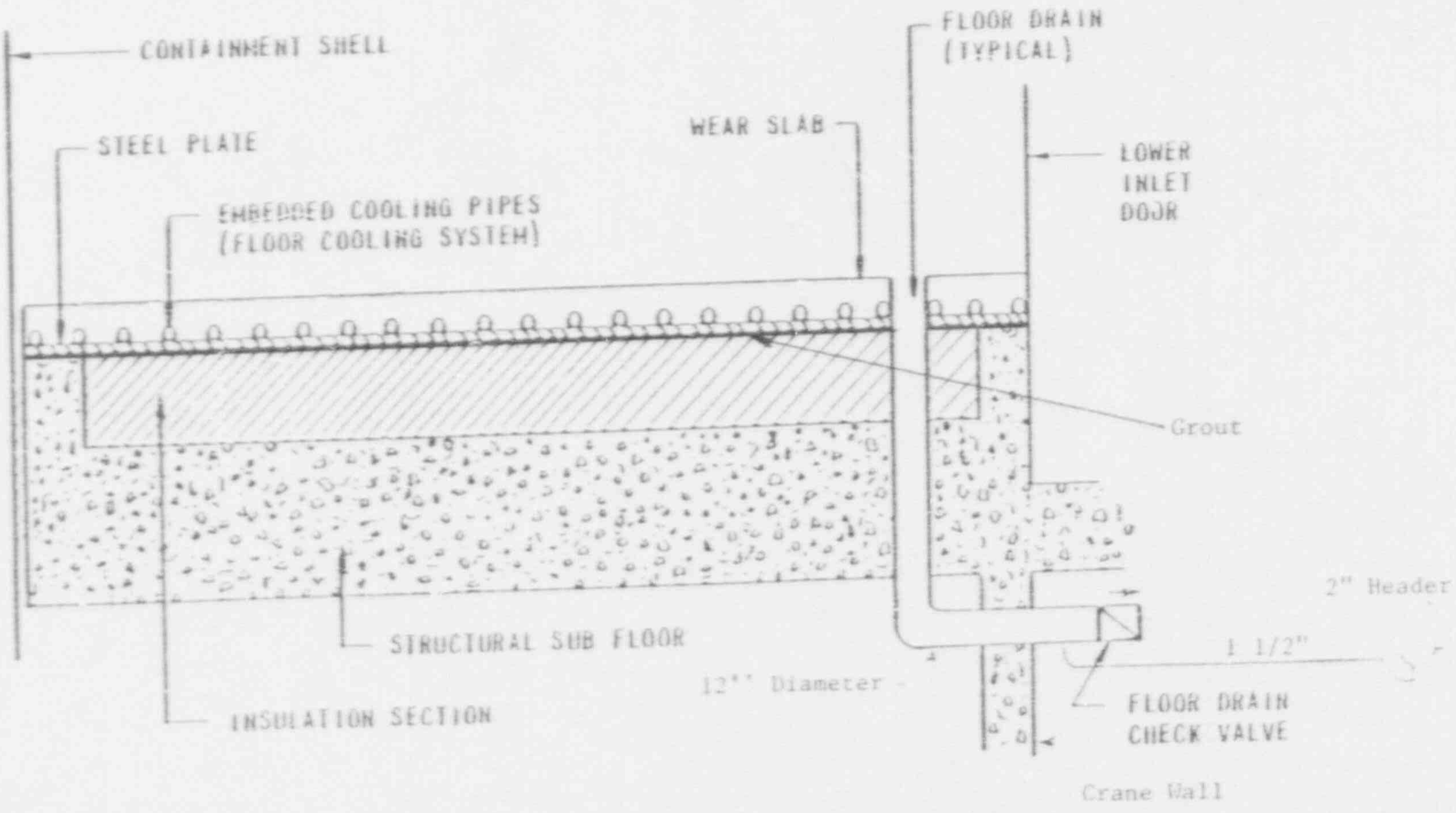


Figure 6.5.1-2 Floor Structure

Attachment 5

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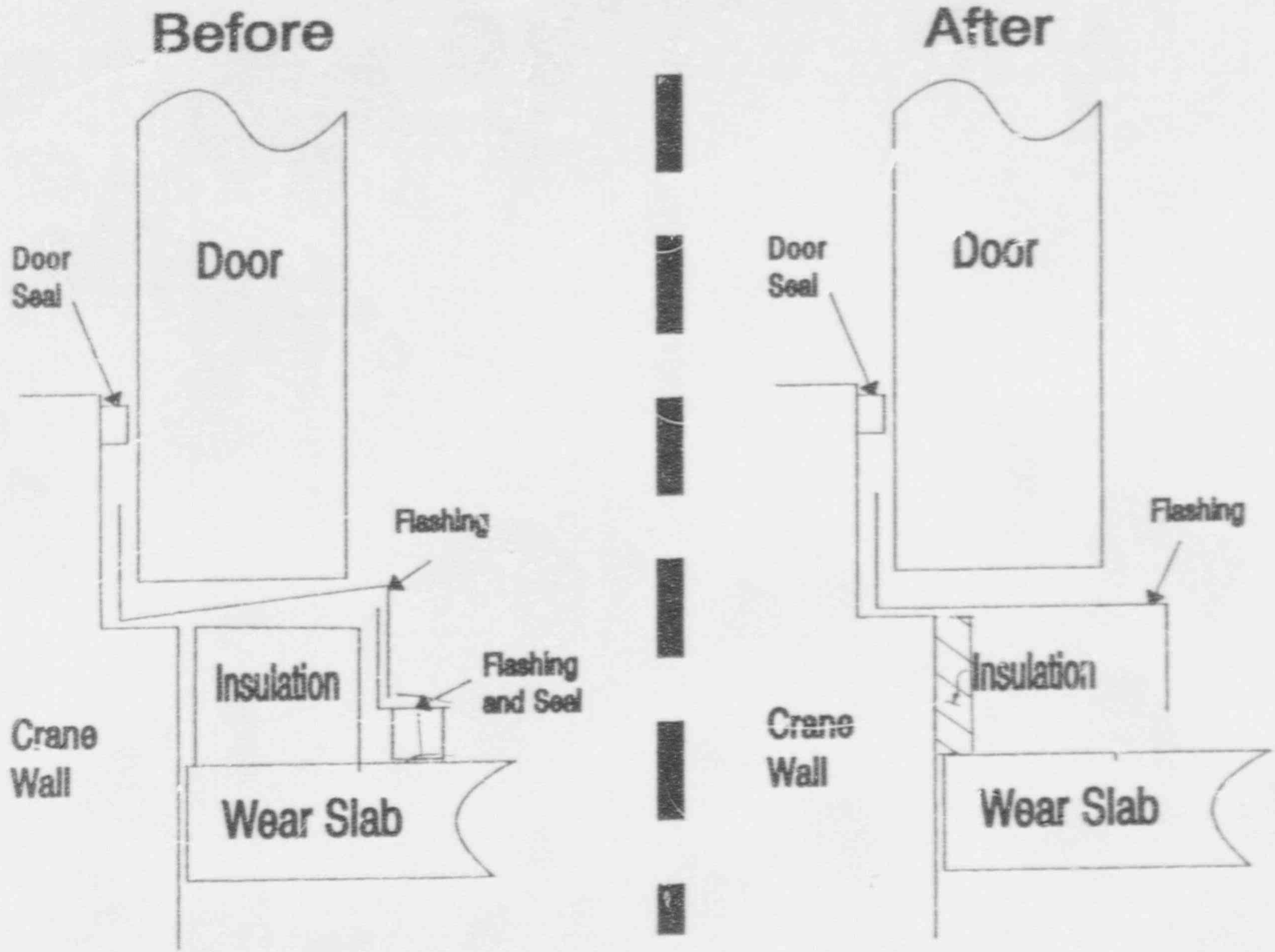

Ice Condenser Lower Inlet Door

ENCLOCURE 2

COMMITMENTS

1. A detailed final inspection to verify appropriate work closeout, material configuration, and area housekeeping will be conducted before entering Mode 4.

2. A full structural and performance evaluation will be performed for Unit 2 similar to that performed for Unit 1 and will receive the same level of review for acceptability. This will be completed before Unit 2 restart from the Cycle 5 refueling outage.

3. To ensure operability of the Unit 2 inlet doors, a modification will be implemented before Mode 4 to install a sheetmetal flashing configuration that will allow for vertical movement. This will provide a long-term resolution that is acceptable from both operation and maintenance perspectives.

4. An additional modification will be implemented before Unit 2 start-up (Mode 4) to seal exposed wear slab interfaces and joints at water intrusion paths, and to seal wear slab cracks as appropriate.

5. Voids and separation in the Unit 2 floor drains will also be repaired as appropriate before Mode 4.

6. On-line monitoring of Unit 2 will be performed as previously described for Unit 1 to verify continued ice condenser operability and assess the effectiveness of the described actions. The monitoring plan will be established before Mode 4.

7. Continued at-power monitoring during Cycle 6 operation and inspections conducted during the Cycle 6 refueling outages will be used to assess the effectiveness of actions previously taken and to establish the optimum long-term resolution for Unit 1.

8. TVA also plans to submit a permanent TS license amendment by June 1, 1992, to provide appropriate action statement(s) for impairments to ice condenser door opening capability.