CP&L
Carolina Power & Light Company

JAN 06 1983

Office of Nuclear Reactor Regulation
ATTN: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261
LICENSE NO. DPR-23
REQUEST FOR LICENSE AMENDMENT
"FINAL" STEAM GENERATOR REPAIR REPORT

Dear Mr. Varga:

The attached report is Carolina Power and Light Company's (CP&L's) final assessment of the activities involved in repairing the H. B. Robinson Unit No. 2 (HBR2) steam generators. This report is an update of our previous, preliminary report submitted to you on September 16, 1982. This report provides additional information which was unavailable or incomplete at the time of the previous report. It also revises certain information previously supplied and responds to some of the draft comments provided by the NRC in an informal transmittal at the end of November.

Some of the comments provided by the NRC are applicable to any good ALARA program. Carolina Power & Light Company fundamentally agrees with the content of these comments and is incorporating the applicable ones in our program.

Following your receipt of this report, CP&L would like to meet with you and/or members of your staff to discuss the present details of this project and respond to any questions you may have regarding this topic.

While CP&L does not agree with your conclusion that a license ammendment is required and reserves the right to protest that conclusion, CP&L is nevertheless proceeding in accordance with your instruction and 10 CFR 2.101 and 10 CFR 50.30, and requests a revision to its license authorizing the repair of its steam generators at HBR2. Please find attached 40 copies of the Final Steam Generator Repair Report. Also, find attached a check in the amount of twelve thousand three hundred dollars ($12,300) for a single Class IV amendment in payment of the applicable license fee in accordance with 10 CFR 170.22.

As stated in our previous correspondence with you regarding this issue, the earliest date that a repair could take place is at an outage which could begin in November 1983. All review schedules should therefore be based on this date. This report is intended to support our previous report to you dated September 16, 1982. As such, all future revisions to this final report will be submitted as page changes with appropriate revision numbers. Should you have any questions regarding this submittal, please contact a member of our licensing staff.

Yours very truly,

L. W. Eury
Senior Vice President
Power Supply

DCS/pgp (5908C10T2)
Attachments

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. G. Requa (NRC)
Mr. Steve Weise (NRC-HBR)

L. W. Eury, having been first duly sworn, did depose and say that the information contained herein is true and correct to his own personal knowledge or based upon information and belief.

Notary (Seal)

My commission expires: OCT 04 1986

FRANKLIN MURRAY NOTARY PUBLIC WAKE COUNTY, N.C.

Superseded per Rev. 1 to SGRR

50-261

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H. B. ROBINSON UNIT NO. 2

STEAM GENERATOR REPAIR REPORT

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STEAM GENERATOR REPAIR REPORT

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1.1 SUMMARY OF STEAM GENERATOR REPAIR PROGRAM

1.1.1 CONTAINMENT ENTRY AND EXIT OF STEAM GENERATOR LOWER ASSEMBLIES

A 1/2" to 1'0" scale model of the portions of the containment building which will be involved in the steam generator replacement project has been constructed for planning purposes, to assist in laydown studies of the steam generator components and to provide a tool for studying rigging and handling methods for the components themselves. The model includes the full operating deck, with major components which will be disturbed during the steam generator work, and the equipment hatch and head storage cavity areas through which the replacement bundles will travel. It also includes the upper lateral restraint for one of the generators, which is typical for all three generators.

The Robinson containment is fitted with an equipment hatch which provides ample dimensions (18' -0" diameter) through which to pass the steam generator components. The existing polar crane can be upgraded to have sufficient capacity to handle the replacement sections and other components. In view of these two facts, it was recognized that alternate pathways, such as a temporary opening in the containment dome, offered no advantage. Therefore, CP&L plans are to proceed using the existing containment openings and equipment. Procedures for equipment handling similar to those used during original plant construction are being considered for this effort. Construction-related evaluations addressed herein cover the equipment hatch pathway only.

1.1.2 STEAM GENERATOR LOWER ASSEMBLY CHARACTERISTICS

The existing steam generators will be parted in the upper section of the shell and at the channel head. The steam dome assemblies (upper portion of steam generator) will be removed and stored within containment. Subsequent to completion of the installation of the new lower assemblies, the original steam dome assemblies will be welded to the new lower assemblies to complete the repair.

The shop fabricated lower assemblies (see Figure 2.2-1) will be equivalent to the lower assemblies they replace. They will be designed to meet existing plant mechanical and performance characteristics, and safety-related parameters will remain consistent with those utilized in the FSAR and subsequent analyses.

Features to mitigate the effects of corrosion-related phenomena are incorporated in the design. These features will not adversely alter mechanical performance or FSAR-related characteristics. In addition, the shop fabricated lower assemblies will be manufactured utilizing current codes and manufacturing techniques. Thus, the replacement assemblies will reflect current technology. They will satisfy the licensing requirement of being equivalent to the units they replace (which were manufactured to the 1965 Edition of Section III, through the Summer 1966 addenda, ASME Boiler and Pressure Vessel Code).

1.1.3 SAFETY-RELATED CONSIDERATIONS

The potential impact of the repaired units on each appropriate accident analyzed in the FSAR has been evaluated. Because of the essential equivalence of safety-related parameters, qualitative discussion is sufficient to demonstrate the appropriateness of the repaired steam generators to accommodate FSAR accidents.

On-site transportation and handling of the lower assemblies have been evaluated as discussed in Sections 3.0 and 5.0. Due to the site arrangement and methods to be used when handling and transporting the steam generator components, temporary protection of underground facilities, safety related equipment and class I structures is not required or appropriate administrative procedures will be followed and/or protective devices installed. The following construction incidents have been postulated:

a) failure of external lifting equipment and subsequent load drop,

b) uncontrolled movement of steam generator transport equipment, and

c) overturning of transport equipment.

The ability of the plant to accommodate any such events is discussed in Section 5.2.

To obviate the need to evaluate in detail construction incidents within the containment during the steam generator repair, the reactor core will be offloaded and transferred to the fuel storage building prior to commencement of major repair activities within the containment.

1.1.4 ALARA CONSIDERATIONS

Comparison of the estimates of man-rem required to complete the steam generator replacement with the man-rem expended during steam generator eddy current testing and repair indicates that an overall reduction of man-rem will be achieved over a period of nine years of operation.

1.1.5 OFFSITE RADIOLOGICAL CONSIDERATIONS

Evaluations of projected liquid and gaseous releases generated by the steam generator replacement project indicate that these releases will be less than those during comparable periods of normal operations. After replacement, normal releases should be reduced as a result of enhanced generator integrity.

1.1.6 UNIQUE ASPECTS OF THE PROGRAM

The shop fabrication of the lower assemblies will be conducted in accordance with standard practices. Welding of the steam dome assembly to the lower assembly in the field was utilized in the installation of the existing steam generators, which were shipped in two sections. This process will be repeated. Concrete removal and replacement will be accomplished utilizing standard construction practices. Transport and lifts of heavy vessels, as well as other heavy loads well in excess of the weight of the lower assemblies, are commonplace during construction of power plants. The heavy loads will be transported along existing trackage except for a short temporary

rail spur to the end of the equipment hatch transfer platform and an added spur to the storage area as shown on Figure 3.1-1. Handling of the heavy loads inside the containment will use existing equipment and pathways similar to those used during initial plant construction. In summary, the repair program will utilize tried and proven manufacturing and construction practices.

1.1.7 STEAM GENERATOR DISPOSAL

The repair activity and ultimate disposal of the existing lower assemblies are separable issues. This report will discuss the various means by which the steam generators can be disposed of to demonstrate the feasibility of disposal. Several disposal options are currently under investigation. The method chosen will depend on economic and radiological considerations. Depending on the method chosen, during the time between removal from containment and ultimate disposal, the lower assemblies will either be stored on site in a temporary storage facility, or placed in a laydown area to await rail shipment to a burial facility.

1.2 IDENTIFICATION OF PRINCIPAL AGENTS AND CONTRACTORS

Carolina Power & Light Company is a public utility corporation duly authorized and existing under the laws of the state of North Carolina. Carolina Power & Light Company is the sole owner and operator of the H. B. Robinson Plant.

Carolina Power & Light Company has developed the engineering and construction management capability to engineer and direct a project of this magnitude and will exercise that prerogative. Assistance in engineering will be obtained from Ebasco Services Incorporated, who performed as the architect-engineer and constructor for the original plant. Selected assistance from other consultants may be employed as needed. The construction will be directed by CP&L utilizing a composite work force of CP&L construction craftsmen, contractor craftsmen, and selected specialty contractors who have proven expertise in certain phases of the work.

Westinghouse Electric Corporation manufactured the existing steam generators and will provide the replacement steam generator lower assemblies. Their expertise will be utilized as appropriate to assist in developing the engineering and construction procedures and in providing site support during the replacement effort.

1.3 OTHER CONSIDERATIONS

Repair or replacement of equipment at a power plant, performed in accordance with appropriate procedures, is a maintenance activity that is routinely conducted. Because of the scope of the steam generator repair, it was considered prudent to evaluate this activity to determine:

a) If the probability of occurence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased; or

b) If a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created; or

installed steam generators to provide additional performance and reliability. The modifications previously accomplished consisted of removing the downcomer resistance plate, modifying the moisture separators, modifying the blowdown arrangement inside the steam generators, installing tube lane blocking devices and modifying the feedring to provide improved performance. These modifications increased the circulation ratio and help the units to resist sludge buildup.

Design data for the steam generators is presented in Table 2.3-1 allowing comparison between the original steam generators and the replacement units. The thermal data for each steam generator will remain the same as the original steam generators. Increased access to the secondary side of the steam generators has been made. The original two 6-inch handholes have been increased to six 6-inch handholes around the bundle in the tubesheet area.

Since the replacement lower assemblies have been designed to incorporate changes based on field experience, a number of minor changes in specific components have been made which could affect the thermal hydraulic performance of the unit. In order to maintain the original thermal and hydraulic conditions, adjustment of heat transfer surface parameters was necessary. Changes in the support plate configuration and the flow distribution resulted in a decrease in the number of tubes from 3260 to 3214.

Most materials used in the fabrication of the replacement lower assemblies will be procured to the requirements of the 1980 Edition of the ASME Code, including the addenda through Winter 1980. These materials will be essentially equivalent to those used in the original steam generators except where specific design changes have been incorporated or fabrication processes have changed. Specific examples of these are as follows: plate material used in the secondary shell has been changed to SA-533 Grade A Class 2 from SA302 Grade B Class 1; support plate material has been changed to SA-240 Type 405 from SA-285 Grade C. Further discussion is provided in Section 2.4, and Table 2.3-2 enumerates past and present applications of materials.

2.3.2 PHYSICAL COMPATIBILITY WITH EXISTING STEAM GENERATORS AND SYSTEMS

New steam generator lower assemblies (see Figure 2.2-1) will be provided. These lower assemblies are designed to be essentially equivalent physical replacements for the existing units. Outside overall dimensions will be the same after lower assembly fitup with the existing channel head and upper shell as will be the location of support attachments. Interfaces between the steam generators and plant components and systems will be maintained. Dry and wet weights of the steam generators will remain approximately the same as will the center of gravity; therefore, no changes to present supports or their configuration are believed necessary.

2.3.3 ASME CODE APPLICATION

The original steam generators were designed and fabricated to the requirements of the 1965 Edition of the ASME Code, Section III including all addenda through Summer 1966. The replacement lower assemblies will be fabricated to the requirements of the 1980 Edition of the ASME Code including all addenda through Winter 1980. Design of the steam generators will be consistent with the original design of the reactor coolant system as well as the upper shell

2.4.1.4 Thermally Treated Inconel 600 Tubing

Research by Westinghouse has determined that additional resistance to the stress corrosion of Inconel 600 tubing can be achieved by modification of the metallurgical structure through thermal treatment. The primary objective of this treatment is to develop metallurgical microstructure, associated with grain boundary precipitation, which provides additional margin against stress corrosion cracking. Several benefits result from this treatment such as additional resistance to stress corrosion cracking in NaOH, resistance to intergranular attack in oxygenated environments, resistance to intergranular attack in sulphur-containing species and reduction of residual stress imparted by tube processing.

Studies conducted at Westinghouse and elsewhere have indicated that certain heat treatments can provide additional caustic stress corrosion resistance but result in a chromium-depleted grain boundary layer (sensitization) which is not as resistant to off-chemistry environments. However, analysis of available data also indicates that there is a broad band of temperature and time within the typical sensitization range for Inconel 600 which provides additional resistance to stress corrosion cracking in both caustic and pure water environments. Thermal treatment in this time-temperature band avoids formation of the chromium depleted grain boundary layer. The thermal treatment to be used will be within this time-temperature band.

2.4.1.5 Offset Feedwater Distribution

Feedwater flow within the steam generator is modified so that approximately 80 percent of the flow is directed to the hot leg side of the bundle and the remaining 20 percent of the flow is directed to the cold leg side of the bundle. This reduces the steam quality in the hot leg side of the bundle and raises the steam quality in the cold leg side of the bundle. The effect of these changes in steam quality is to shift the point of highest steam quality at the tubesheet elevation toward the center of the bundle. The point of highest steam quality has the lowest density and is, therefore, a likely region for chemical concentration and sludge deposition. This area is utilized for location of the blowdown intake. Feedwater flow distribution is accomplished by providing a greater number of flow paths on the portion of the feedwater ring which traverses the hot leg side of the tube bundle.

2.4.1.6 Corrosion Resistant Support Plate Material

Corrosion in the crevice between the tube and tube support plate has led to denting of the steam generator tubing in that area. Alternative support plate materials have been evaluated, and SA-240 Type 405 ferritic stainless steel has been selected as an appropriate material for this application. This material is ASME Code-approved and provides additional resistance to corrosion. In addition, SA-240 has a low wear coefficient when paired with Inconel and has a coefficient of thermal expansion similar to carbon steel. Corrosion of SA-240 results in an oxide which has approximately the same volume as the parent material, whereas corrosion of carbon steel results in oxides which have a larger volume than the parent material. In addition to the tube support plates, the baffle plate discussed in Subsection 2.4.1.1 will be constructed of SA-240 Type 405 stainless steel.

3.0 COMPONENT REPLACEMENT PROGRAM AND PROCEDURES

This section discusses the engineering evaluation of the field activities required to implement the steam generator repair. Figure 3.0-1, Outage Sequence, and Figure 3.0-2, Removal Sequence, illustrate the probable lower assembly removal approach and general plan for the replacement program. It should be noted that implementation methods and procedures may vary from those described below as engineering is finalized. The methods below are provided to demonstrate feasibility of implementation. Any changes incurred during detailed design will not alter the envelope of construction incidents postulated in Section 5.2.

The steam generator lower assemblies will be removed and replaced through the equipment hatch. The steam dome assemblies will remain inside the containment and will be stored on the operating floor level, elevation 275', while the lower assemblies are replaced. The probable storage locations of the major components are shown on Figure 3.0-3, Major Component Laydown.

Handling of the steam generator assemblies inside the containment will be performed by the existing polar crane. The polar crane will be modified as necessary to facilitate upgrading from the current 155 ton rated capacity to a capacity of approximately 210 tons. The lower steam generator assemblies will be raised above the operating floor and moved to a point above the head storage cavity by rotating the crane and traversing the trolley as required. Trolley travel will be restricted by mechanical means in accordance with any limits set forth by the rerating analysis.

A transfer platform will be constructed through the equipment hatch into the head storage cavity which will provide the structure on which to move the generator lower assemblies in and out of the containment building. This platform elevation will be approximately 235' or about 10' above yard grade. The polar crane will lower the lower assemblies onto a movable upending fixture located on the platform. The lower end of the assembly will be drawn out through the equipment hatch as the polar crane lowers the upper end onto a receiving saddle. The upending device and upper end support saddle will be track or roller mounted for ease in maneuvering through the hatch.

Outside of the containment building, the lower assemblies will be transferred to special heavy duty railcars by a lifting frame assembly which will pick up and move the load longitudinally. Special railcars will be used to transport the lower assemblies between the containment and laydown or storage areas as required. A short section of temporary track will be constructed from an existing spur line to the end of the containment equipment hatch transfer platform. Safety precautions guarding against a runaway rail car which could result in possible damage to the containment structure are discussed later in this report. Refer to Figure 3.0-4 and 3.0-5 for additional details.

The transfer platform for handling the lower assemblies will be supported on cribbing or steel framing directly from the containment ground floor, which is at Elevation 226', and is integral with the building foundation.

An adequate laydown area for the temporary location of the upper steam generator sections is available on the containment operating deck and by providing temporary supports across the refueling canal. Structural adequacy

of these supports and the laydown areas for the 110-ton steam dome assemblies are being evaluated.

Cylindrical reinforced concrete biological shield walls mask the portion of the lower assemblies which project above the operating deck. Approximately the top 2 to 3 feet of these shield walls will be removed to provide access for cutting the welded joint between the steam dome and the transition cone of the lower section. Removal of this top section of shield wall will provide adequate head room for the polar crane to lift the lower steam generator sections above the operating deck and biological shield, and to move them to the exit. The removed shield wall sections will be replaced due to ALARA considerations for future operations.

Clearance for equipment making the cut between the lower assemblies and the channel head is adequate for steam generators B and C. Steam generator A access will require removal of approximately 1 cubic yard of concrete to provide room for the automatic cutting machine to travel around the vessel. Impact on existing equipment or structures is minimal.

Removal of the lower assemblies through the existing equipment hatch will have minimal impact on the site layout in terms of new foundations or additional facilities. The lower assemblies during rail transit to and from the storage/laydown area will not be required to cross any underground safety related equipment.

Special foundations will be required adjacent to the equipment hatch for the lifting frame, but these will not affect any existing structures or underground services. The shield blocks normally located at the equipment hatch will be used to form part of the external temporary runway which extends from inside the containment building as shown on Figures 3.0-4 and 3.0-5. No permanent modifications to existing structures are expected. The external portion of the equipment hatch will be protected from possible damage by placing a structure across the top of the shield walls as shown on the above referenced drawings. Analysis of potential damage due to failure of lifting equipment is discussed in Section 5.2.

3.1 CONSTRUCTION FACILITIES

3.1.1 GENERAL

Special facilities and preparations in the plant yard area and inside the containment building will be required in support of the steam generator replacement. The plant building arrangement is such that there is an adequate yard area directly in front of the equipment hatch which is free of any permanent facilities. This circumstance allows ample space for construction of temporary facilities to handle personnel, material, and the large steam generator components with little impact on plant permanent facilities or plant safety.

Figure 3.1-1 shows the total site with lay-down areas, construction buildings, temporary roads and railroads, and the planned pathway for movement of the steam generator lower sections. It is expected that the replacement lower assemblies will be on site prior to the start of the replacement operation and their temporary storage location is shown.

Figure 3.1-2 shows an enlarged plan view of the area directly in front of the equipment hatch and exhibits the main features of the entry/exit facility, the transfer platform, and the equipment for steam generator handling.

Figure 3.0-3 shows the location and planned arrangement of removable containment operating deck sections which will be used in providing additional lay down space by bridging and decking the refueling canal.

3.1.2 SITE PREPARATION

Construction facilities (office, warehouses, shops, etc.) are already established at the Robinson Plant for the performance of miscellaneous modifications and will be used as well for modifications associated with the steam generator replacement.

The construction facilities are located entirely within the security boundary providing convenient access to the work areas. Consideration is being given to the possible need for expanding this available area by moving the existing west fence further west, and for providing a secondary personnnel and vehicle entry building at the west security boundary. Construction of a new permanent maintenance building may be completed and would be utilized as a warehouse/construction/contractor building during the steam generator work. Sanitary treatment facilities for the site are also being increased and together with supplementary temporary facilities will be adequate for the large construction work force.

The new steam generator sections will be received by rail and a dedicated temporary railroad spur will be constructed for their temporary storage. The storage location will be north of the plant in a graded area adjacent to the coal handling tracks and west of the existing yard storage area (See figure 3.1-1). The generator sections will be lifted or jacked up from the delivery car, the car pulled away, and the sections lowered onto temporary storage saddles without removing the railroad track. This method has been selected for ease of retrieval when the bundles are later put back on a railroad car and moved to the containment building.

A second temporary railroad spur as previously discussed will be constructed extending from an existing spur line to a point in front of the equipment hatch transfer platform and extending under the lifting frame. During movement of the special heavy duty rail cars between the containment and storage/laydown area, positive restraint will be provided by the switching locomotive. Redundant cables will also be provided between the locomotive and railcar to preclude the unlikely event of inadvertent uncoupling during movement. The containment spur will be of standard construction at or slightly above grade elevation. The only permanent facilities the new spur will cross are an underground fire line, direct burial lighting cables, and building services (water, sanitary, power) for nonsafety related buildings. These facilities will be protected from damage by the heavy rail loads.

3.1.3 CONTAINMENT PERSONNEL ACCESS BUILDING

A temporary enclosure will be provided adjacent to the equipment hatch for personnel change areas, radiation control check points and facilities, and as a storage area for tools and portable equipment. There will also be an area

dedicated to staging materials in and out of the containment. The enclosure will be extended to the equipment hatch so that ventilation control can be maintained inside the containment. Removable wall sections will provide passage for the steam generator sections and material transfer rail carts. Probable layout of the enclosure is shown on Figure 3.1-2.

3.1.4 MATERIAL HANDLING OUTSIDE CONTAINMENT

Material handling outside the containment at the equipment hatch will be provided by:

a) A fifteen ton capacity hydraulic mobile crane with telescoping boom

b) Rail or roller mounted carts (mounted on the transfer platform) which can be moved in and out of the containment

c) Special lifting frame designed to handle the steam generator lower assemblies

d) One hundred forty ton truck crane (Link-Belt Model HC238) or equivalent. The crane will be equipped with 100' of boom. Actual crane capacity and model could vary depending on actual weight of special lifting frame components.

The area will be appropriately compartmented to provide necessary contamination and health physics controls.

3.1.5 CONTAINMENT PREPARATIONS

3.1.5.1 Polar Crane

The existing polar crane as discussed previously was temporarily rerated during original plant construction to accomodate handling the 212 ton lifts required by the lower steam generator assemblies. The crane will again be rerated to accommodate the steam generator replacement evolution. Rerating studies are currently being performed by the crane manufacturer (Whiting Corp.). Modifications, based on results of Whiting's analysis, will be incorporated to facilitate rerating the crane for the desired lifts. Upon completion of any modifications, the polar crane will be load tested. Since the crane is being uprated from 155 ton capacity to approximately a 210 ton capacity, a standard 125% load test is not considered feasible. A 100% load test will be performed using the actual load. A written procedure will be provided to accomplish the load test. In addition to and prior to the load test, a thorough examination of the crane will be performed, including NDE of the crane hook, and inspection of all major load bearing components and mechanical and electrical equipment that have not been modified or replaced.

The lower steam generator assemblies will be lifted using conventional rigging techniques. One method of rigging to the polar crane main load block is by a pin to a steam generator lift beam equipped with toggle arms or endless grommet type slings. The toggle arms or slings will be attached to existing lifting trunions on the lower assemblies. Each lower assembly will be lifted to clear obstacles on the operating deck and rotated to a point over the center of the head storage area and approximately on center line with the

equipment hatch. The lower assembly will then be lowered onto a special tilting assembly. The special tilting assembly consisting of a Hillman roller unit or equivalent and structural members (details of this device have not yet been determined) is required to permit the lower steam generator assembly to move from the vertical to horizontal position. As the lower assembly reaches the horizontal position a second roller assembly and saddle will be placed under the upper end of the lower assembly. The lower assembly will then be transferred through the equipment hatch and lifted by the special lifting frame.

Polar crane operators as well as all other crane operators will be trained and qualified in accordance with current approved procedures. Only qualified personnel will be permitted to operate the cranes. Written procedures describing the methods, precautions and proper load paths will be followed for handling the heavy equipment.

3.1.5.2 Laydown Space Provisions

The portion of the operating deck above the reactor head storage compartment consists of a number of removable reinforced concrete beams which are removed for head storage or for access to the equipment hatch level by the main hook of the polar crane. During steam generator replacement, the reactor head will be in place on the reactor and the "pie blocks", as the removable beams are termed, must be out of the way. The "pie blocks" will be stored spanning the refueling cavity and may be spaced and decked so as to form a laydown area for one of the three steam generator dome sections. The reactor vessel CRDM missile shield will also be decked over to provide a storage position for a steam dome, and the third and fourth necessary locations can be selected from four possible positions on the operating deck. Figure 3.0-3 shows potential laydown areas for the major components during the replacement evolution. Selection will be made after final development of any other work planned to be in progress on the operating deck.

Engineering and structural analyses will be performed to verify that the existing structures are capable of supporting the temporary laydown loads without permanent modifications. The major items requiring investigation are:

a) Steam generator dome assembly laydown areas.

b) Loads on base mat from transport of the steam generator lower sections.

c) Temporary laydown area spanning the refueling canal.

d) CRDM missile shield.

3.1.5.3 Steam Generator Transfer Platform

The transfer platform outside of the equipment hatch will be at an elevation to allow its extension through the hatch, across the annulus between the crane wall and the exterior containment wall and into the head storage compartment. Loads from the transfer platform will be transmitted directly to the containment floor by structural steel posts or cribbing (a distance of less than 7 feet).

The transfer platform will support the transport and upending fixtures during movement of the steam generator lower assemblies through the hatch and while upending or laying the assemblies down as they are moved from the hatch to the operating deck by the polar crane.

The transfer platform will also provide personnel and material access pathways and will be fitted for rail carts to move material through the hatch.

3.1.5.4 Miscellaneous Hoisting Equipment Inside Containment

The existing jib crane at the operating deck level which is now maintained to serve a removable deck hatch in the annulus area above the containment equipment hatch will be upgraded or replaced. It will be used to raise miscellaneous materials to the operating deck and will reduce demands for the polar crane.

In addition, temporary low capacity cranes will be provided inside containment to provide additional hoisting capacity during the disassembly and assembly operations.

3.1.5.5 Containment Ventilation

Existing ventilation systems will be used to provide the main input to air circulation and to control ventilation within the containment. Exhaust air will be handled through the existing vent facilities to utilize the existing monitoring and filtering equipment.

Provisions will be made to provide cooled air to the steam generator bays using temporary cooling equipment and ductwork. During certain operations, the bays may be enclosed to contain any airborne contamination and will be exhausted through portable HEPA filter units.

3.1.5.6 Service Air and Power

Supplementary service air and power will be provided with compressors and an electrical load center outside the containment. Air hose and power leads will enter the containment through existing openings or below the equipment hatch transfer platform.

3.1.6 TRANSPORTATION ON SITE

Transportation of the steam generator lower assemblies will be by rail car on existing or temporary spurs as previously described.

The storage area (for both new and replaced assemblies) is located in the graded area northwest of the plant adjacent to the outside storage yard.

Rail access to the storage area (a new spur from the existing coal unloading track system) and transport to the plant yard spurs and thence to the containment hatch will be accomplished entirely on plant property and plant trackage. Using this planned route has the advantage of minimizing any potential for damage to the permanent facilities by a transport accident, since the route is generally remote from any permanent facility. (See Figure 3.1-1).

A derail device will be installed on the temporary rail spur at the beginning of the temporary spur to preclude any possibility of damage to temporary rigging equipment from a runway railcar. The derailer will be removed during transfer of the lower steam generator assemblies and then replaced. Positive restraint will be applied to the railcars whenever in transit. Railcars when not in transit will have their braking system applied and chocking installed between the wheels and rail. Refer to Figure 3.1-1 for temporary rail spur.

3.1.7 STORAGE HANDLING FOR REPLACEMENT LOWER ASSEMBLIES

As previously discussed a temporary rail spur will be constructed for storage of the new lower assemblies. Upon arrival onsite the assemblies will be shifted to the temporary storage spur and offloaded from the rail cars onto a beam and concrete pedestal arrangement. One of the probable methods would be that each end of the lower assembly would be lifted separately by the 140 ton capacity truck crane and a beam assembly with saddle, which spans between two (2) pedestals, would be placed under the lower assembly. After both ends have been raised and properly secured on the storage beams the rail car will be moved out from under the assembly. Figure 3.1-1 shows the rail spur location.

3.1.8 RIGGING CONFIGURATION

The existing polar crane bridge and hoist will be modified, if required, to sustain the loads imposed by a lower assembly and its rigging. Rerating studies and investigation of any necessary modifications are being performed by the original crane manufacturer and any required alterations will be performed.

The steam dome assemblies will be removed from the lower assemblies and lifted by existing pad eyes and commercial slings and rigging hardware. They will be relocated to preselected storage areas, and subsequently handled as necessary to perform modifications to the internals and to prepare the weld joint for rewelding to the new lower sections. The assemblies weigh approximately 110 tons each and are well within the present capacity of the polar crane.

The lower assemblies will be lifted from their compartments using conventional hoisting techniques. Existing trunnions on the assembly will be engaged using either conventional slings or a special steam generator lift beam equipped with toggle arms. The polar crane sister hook is equipped to attach a lifting beam with a pin or to accept two balanced slings.

The existing lower sections will be parted from the channel heads, hoisted sufficiently to clear the truncated shield walls and transferred to a point over the head storage cavity. Movement pathways are shown on Figure 3.1-3. The location is about 35 feet from the containment exterior wall and directly opposite the equipment hatch. The sections will be lowered to the transfer platform and the lower end landed on a special upending fixture which will be roller mounted. The lower end of the assembly and its upending fixture will be drawn out toward and through the equipment hatch while the polar crane continues to lower the upper end. A roller mounted saddle will receive the upper end of the generator lower section when a horizontal position has been achieved, the polar crane will be released, and the lower assembly will be pulled out through the hatch. See Figures 3.0-4 and 3.0-5.

A special lifting frame will be erected outside the containment equipment hatch straddling the hatch transfer platform and temporary rail spur. The lifting frame will be load tested in accordance with a written load test procedure prior to actual use. The old generator lower section will be lifted off the transfer platform by the lifting frame trolley and transferred to the railcar for movement to storage (reverse order for new lower sections).

The actual sequence of moves will be selected to optimize use of the polar crane and other sequential operations, but will likely be in the following order:

a) Remove upper generator Section A.

b) Remove upper generator Section C.

c) Remove lower generator Section A.

d) Remove lower generator Section C.

e) Remove upper generator Section B.

f) Remove lower generator Section B.

g) Replace lower generator Section C.

h) Replace lower generator Section A.

i) Replace lower generator Section B.

j) Replace upper generator Section C.

k) Replace upper generator Section A.

l) Replace upper generator Section B.

3.1.9 RIGGING AND HANDLING CONTROLS

The rigging arrangements discussed herein and inherent plant arrangement show that crane and or crane boom failure would not adversely impact the ability to achieve and maintain safe shutdown conditions and provide adequate cooling water for stored spent fuel regardless of which direction the crane might fail. All structures required to maintain the plant in a safe shutdown condition would maintain structural integrity. Postulated failures of lifting equipment are discussed in Section 5.2. of this report.

As previously discussed, rigging and material handling operations will be performed in accordance with current approved procedures as well as special procedures specifically developed for steam generator replacement. These procedures will be in conformance with the requirements of OSHA, ANSI B30 series, and other appropriate federal regulations and guidelines.

The administrative controls to be implemented address such items as:

a) Limit of lift height - loads will be raised only to a height sufficient to provide adequate clearance for horizontal movement.

b) Travel speed and routes for cranes and other transport equipment will be controlled to avoid vital structures and to minimize the potential for load handling incidents.

c) Predetermined load paths and travel routes will be identified in procedures. These load paths are tentatively shown on Figure 3.1-3.

d) Lifting equipment will be thoroughly inspected and load tested prior to use. Visual inspection of lifting apparatus will be performed prior to each lift.

e) Only qualified operators will operate cranes.

f) Ground bearing capability in lifting areas will be considered prior to initial use of cranes.

g) Derailer on temporary rail spur

h) Since safety related functions will not be adversely affected by a postulated toppling of a crane, special seismic/high wind criteria which exceed normal construction practices will not be required.

3.2 CONCRETE, STRUCTURAL, AND EQUIPMENT INTERFERENCE REMOVAL AND REPLACEMENT

Engineering evaluations are being conducted to determine the impact of repair activities on equipment and structures in the containment. This evaluation is being conducted to ensure that the repair activity will not result in unreviewed safety questions due to equipment removal or interruption of safety related functions.

Detailed engineering studies are in progress to precisely define the structures, components, pipes, cables, conduits, instruments, ducts, etc. within the containment affected by the repair activity. The discussion that follows provides the results of the study to date. It is provided to illustrate the minimal impact on safety related equipment within the containment.

3.2.1 MECHANICAL EQUIPMENT

It will not be necessary to remove any mechanical equipment in order to provide access to the generators or to provide a movement pathway.

Laydown area requirements and provisions of a load traverse path from the generator cavities to the equipment hatch requires partial dismantling of the manipulator crane. The crane mast will be removed and stored in the refueling canal after fuel has been removed from the building. The overhead frame and monorail will also be dismantled and stored in the canal. The manipulator crane will then be rolled as far south as possible (temporary rails will be

provided). This location will permit reinstallation of the CRDM missile shield without interference. Suitable protection will be provided for the manipulator crane controls.

3.2.2 PLATFORM AND STRUCTURES

Two sections of platform must be removed and stored for reinstallation. Both are of steel frame construction with bolted connections and grating decks. Conduit and piping supported on these platforms will be either relocated, or removed and replaced after platforms are re-erected.

The existing platform now serving the equipment hatch inside the containment will be removed and replaced by a transfer platform with capacity to support the steam generator sections.

Directly above the equipment hatch, a portion of the mezzanine (Elevation 251.5') deck must be removed to provide clearance for the steam generator rotation from vertical to horizontal as it moves through the hatch. No modifications to these platforms are required. Temporary storage may be either within the containment or outside in a protected area.

3.2.3 REINFORCED CONCRETE

Approximately the top 2 to 3 feet of the steam generator biological shield walls must be removed to provide access to the steam dome cut line. The wall sections will likely be removed by abrasive cutting in large sections. The sections will be salvaged and later reinstalled. Crevices between blocks would be filled with mortar to prevent possible streaming.

A portion of a missile shield wall adjacent to steam generator A must be removed to allow clearance for the automatic cutting equipment. Removal of about 1 cubic yard of concrete is required. An engineering study will be performed to determine if the wall section must be replaced, or if another type construction (such as steel plate) can be substituted with less impact on the project. Should replacement in kind be necessary, it will be performed by splicing the existing reinforcing steel using normal construction methods.

3.2.4 PIPING SYSTEMS

The major piping which must be removed are the sections of main steam and feedwater lines connecting to each steam generator. Both lines will probably be cut at the steam generator nozzles and in the vertical runs at an elevation convenient to the operating floor. No cuts will be made until the remainder of the piping system has been temporarily stabilized and restrained. The locations of the cuts are shown in Figure 3.2-0. All open ends of cut piping will be capped and/or plugged to ensure cleanliness during the repair program.

Other piping to be removed and/or relocated include the following:

a) Steam Generator blowdown piping, as required.

b) Vent piping, as required.

c) Sections of small bore service air, instrument air, and fire protection lines, which are supported by the mezzanine to be removed for steam generator clearance, will be relocated prior to mezzanine removal.

Removal of piping systems will be accomplished by machine cutting with remotely controlled equipment or with the option of flame cutting where limitations or advantages warrant.

The governing overall code for the steam generator replacement shall be ASME Section XI, 1980 Edition with addenda through the Winter of 1980. All piping work will be per the original plant criteria, the Power Piping Code (B31.1) as discussed in the H. B. Robinson Updated FSAR.

3.2.5 INSTRUMENTATION

The following instrumentation, sensing lines, and associated supports will be temporarily disconnected and/or removed, and stored in the containment area:

Steam Generator "A"
Level Transmitters - LT 474, LT 475, LT 476, and LT 477

Steam Generator "B"
Level Transmitters - LT 484, LT 485, LT 486, and LT 487

Steam Generator "C"
Level Transmitters - LT 494, LT 495, LT 496, and LT 497

All open ends of sensing lines will be capped to ensure cleanliness during the repair period.

In the appropriate sequence of the SG reinstallation schedule, the level transmitters and sensing lines will be reinstalled and returned to service using standard procedures.

Disconnection of associated instrument cable is discussed in Section 3.2.6.

3.2.6 CABLE AND CONDUIT

The steam generator repair program does not require the removal or relocation of any major pieces of electrical equipment and control equipment, except the level transmitter equipment noted in Section 3.2.5 above.

Only power and instrument cable and conduit as described herein are affected.

a) Instrument cable for the level transmitters noted in Section 3.2.5 above will be temporarily disconnected at the cable terminations, and will be pulled back and coiled out of the path of the equipment removals. They will be properly tagged and identified for subsequent reinstallation after the major equipment is returned to position and placed into service utilizing standard procedures.

b) One (1) 1 1/2" electrical conduit will be removed and/or relocated to accommodate removal of equipment through the equipment hatch.

c) Provision of the necessary electrical power inside the containment will require utilization of selected permanent equipment power circuits. Temporary load centers will be provided inside the containment but may require temporary disconnection of equipment power cables either at the equipment or at the containment penetrations. Normal jumper and wire removal procedures will be used to keep track of these changes.

d) Table 3.2-1 will be provided (later) to identify the Unit 2 circuits to be temporarily disconnected and/or removed.

3.2.7 DUCTWORK

Short sections of permanent ventilation duct must be removed to provide adequate working room at the channel heads of steam generators A and B. The ductwork is of welded construction and the removed portions will be salvaged and reinstalled without modification.

3.2.8 STEAM GENERATOR UPPER LATERAL RESTRAINTS

Seismic restraint for the steam generator is provided by a ring girder located just below the operating deck. The ring permits movement to accommodate thermal expansion, but is prevented from lateral motion by traveling in guides. Hydraulic snubbers control movement in the direction of the thermal expansion.

Plans are being prepared to effect the SG replacement either with minor or extensive dismantling of the restraint structure. The decision will be made later as to the method when access can be obtained for precise measurement of both the rings and the replacement generator sections. A model of the area and the upper restraint has been made to aid in the development of our replacement plan.

3.3 STEAM GENERATOR MID-SECTION REPLACEMENT

3.3.1 STEAM GENERATOR CUTTING METHODS AND LOCATIONS

Following removal of steam and feedwater piping connections to the steam dome (either by machine or flame cut) the steam dome will be parted by use of a track-mounted torch cutting unit at the site of the original weld between dome and transition cone. Sufficient material will be left to allow a finish weld preparation cut to be made prior to reinstallation. The inside wrapper will also be parted by flame cutting and the entire assembly removed. ALARA considerations will be paramount in developing this activity in view of the high radiation level from the steam generator tubes. After removal of the steam dome, a metal shield will be welded in place over the open end of the lower steam generator section.

The lower assembly will be separated from the channel head by track-mounted machine cutting methods for the circumferential cut, following a plasma arc cut of the channel head divider plate. The cut location will be at the site of the original weld between channel head and tube sheet.

Where flame cutting is used, appropriate preheating will be used to ensure integrity of the component.

3.3.2 STEAM GENERATOR REASSEMBLY

Following removal of the existing lower assembly, the channel head and divider plate will be machined to the appropriate contour for the replacement weld. Portable milling equipment is available for this operation and will be utilized. The steam dome weld preparation will be manual.

The weld joint design for the channel head will generally follow the methods used at Turkey Point and will permit most of the welding to be performed from outside the vessel. A detail of the proposed weld preparation is shown in Figure 3.3-1 which is to be provided later.

After completion of weld prepping of the existing lower channel head, Figure 3.3-1, a new steam generator lower assembly will be lowered into position and welded, followed by the replacement of the reworked moisture separator dome.

3.3.3 WELDING CODES, PROCESSES, AND MATERIALS

All lower assembly welding post weld heat treatment and NDE inspection during installation shall be in accordance with the ASME Code Section XI, and ASME Code Section III Div. 1, 1980 edition with addenda through the Winter of 1980, with the exception of code stamping of the component assemblies.

The piping welds shall be made using manual shielded metal arc (SMAW) process with E7018 electrodes. The steam generator vessel walls at the upper dome and lower channel head will be welded by the SMAW process using E8018 electrodes. The rewelding of the existing channel head to the new tube sheet Z seam will require the application of a new corrosion resistant weld cladding over the inside diameter weld joint surface of the bowl once the weld joint has been completed. This cladding will be accomplished with SMAW process using Inconel electrodes.

The stress relief heat treatment of welded joints will take into account the previous total accumulative soak time of the existing steam generator components to ensure full compliance with ASME code requirements. Welded joints shall be locally post weld heat treated (PWHT) by electrical resistance heating at the temperature of 1125° F ± 25° F to provide stress relief. During preheating and PWHT, thermocouples and insulation shall be utilized for maximum temperature control and to limit heating of other areas and components.

In order to minimize stresses on the cladded tubesheet, the existing Inconel divider plate will be welded to the Inconel stub on the new steam generator lower assembly after the other steam generator welding and PWHT is complete. The welding process will be TIG process with Inconel bare wire.

Two different decontamination methods are presently being evaluated for primary surface decontamination. They are:

a) Fill and Soak - This would involve filling the primary side of the SG with a suitable decon solution and allowing sufficient soak time for the solution to work. This soak would be followed by a rinse of the primary side. The liquid waste would be processed as appropriate and drummed for off-site disposal.

b) Mechanical - A technique that would spray a wet abrasive grit at a high velocity against the area to be decontaminated. This method removes the surface layer of the metal that contains the radioactive contamination. The abrasive, surface contamination and corrosion products are filtered out of the wet slurry and drummed for off-site disposal. The liquid stream would be processed as appropriate and drummed for off-site disposal. This method was used at San Onofre Unit 1 and Turkey Point Unit 3.

Carolina Power & Light Company will continue to evaluate which method or combination of methods will lead to the most effective man-rem utilization.

3.4.1.2 Temporary Shielding

Temporary shielding will be used as necessary to reduce the exposure rates from nearby components. Decisions involving the use of temporary shielding will be made on a case-by-case basis weighing man-rem saved against man-rem expended to shield. Other factors such as space limitations and floor loading limitations will also be considered.

The following are areas where the use of temporary shielding is anticipated:

a) Components, such as contaminated piping and valves adjacent to intensive work areas will be shielded.

b) "Hot spots" due to concentration of contaminants in piping or valves will be flushed if possible and will receive special attention or shielding as appropriate.

c) Shielding will be provided for the steam generator lower assembly ends in the form of steel cover plates. The upper end plate will be installed as soon as the steam dome is cut and lifted away. The lower end (tube sheets) cover plate will be installed when the assembly is lifted above the operating deck but before it is lowered into the head storage cavity in front of the equipment hatch.

d) The steam generator lower assembly will be essentially filled with water while the steam dome is being removed to reduce radiation exposure from the contaminated tubes.

It is not expected that shielding in addition to the lower assembly end cover plates will be required during removal of the steam generator lower assemblies and the transportation to storage or disposal.

e) The steam generator channel head will be shielded and/or further decontaminated after removal of the lower assembly.

procedures and additional special requirements. This training will consist of the following:

a) General Employee Training - Employees will receive comprehensive training in ALARA philosophy, biological effects of radiation, dose reduction measures, and use of protective equipment.

b) Job-Specific Training - Selected groups will be trained in specific hazards associated with specialized components such as the steam generator.

c) Dry-Run Training - When necessary, procedures will be attempted before going into a radiation area. This guarantees complete understanding of complicated sequences and reduces non-productive time.

d) Mock-Up Training - When practical and necessary, work will first be attempted on a suitable mock-up. This will familiarize the worker with the equipment and cause the job to flow more smoothly.

3.4.2 ACCESS CONTROL

In order to facilitate containment access and control of the contractor force expected during the project, a temporary facility will be constructed adjacent to the equipment hatch. This facility will be a suitable enclosure which will include provisions for:

a) Dress-Out Area

b) Sanitary Facilities

c) Control Checkpoint

d) Frisking Station

e) Respirator Checkout Area

f) Tool Room

Personnel will follow accepted procedures while processing in and out of the facility.

Personnel will enter the change/dress-out area, dress out, and proceed to the radiation control checkpoint. From there, they will enter the containment building through the equipment hatch. Personnel leaving containment will remove their protective clothing in the undressing area and frisk before returning to the change/dress-out area. In event personnel decontamination is necessary, a passage is provided to the existing plant contaminated shower/decontamination facility. Additional Health Physics access control will be provided where necessary at selected points inside the containment building as well as at the temporary access control area.

Provisions will be made for easy and rapid access to the HP counting room to provide fast turnaround on contamination checks. A new radiological laboratory facility is planned for construction prior to the scheduled steam

cement. Both methods also result in the creation of contaminated rinse water which is cleaned up by portable filters and demineralizers and further processed in the plant's radwaste system.

3.4.7.1 Radioactive Waste Volume and Activity

A total of about 60,000 ft^3 containing 160(1000)* curies of radioactive waste is estimated to be generated during the SGRP. This estimate is based on existing volume reduction practices at H. B. Robinson as well as volumes and activities generated during previous H. B. Robinson outages and SGRP outages at other utilities.

The quantity of waste by category is:

Type	Volume (ft^3)	Percent (%)	Curies
DAW and Concrete	41,000	68 (64)	90
Solidified Evaporator Concentrate	18,000	30 (28)	20
Solidified Decon Liquids	1000 (5000)	2 (8)	55 (890)
Total	60,000 (64,000)	100	160 (1000)

Significant savings in volume of radwaste packaged for shipment off-site can be realized by utilizing various volume reduction techniques. CP&L is investigating various reduction techniques, e.g., box compactor, enhanced segregation program, shredder, etc., and plans to utilize some of these techniques during the SGRP.

Solid waste will be compacted, if possible, to minimize the volume and will be disposed of in accordance with applicable CP&L procedures, US DOT regulations, and burial site criteria. CP&L is developing a process control system for the solidification of radwaste which will meet the intent of NUREG-0472, Revision 3.

3.4.8 MAN-REM ASSESSMENTS

In order to determine the radiological feasibility and impact of the replacement project as a whole, to establish a framework for the evaluation of construction alternatives, and to provide a benchmark for measuring the effectiveness of the ALARA program, a man-rem-by-task assessment has been performed.

As a prerequisite for this evaluation, detailed radiation surveys were made on all three generators using a model 6112 Teletector. These surveys were conducted with the primary sides drained and the secondary sides filled to

* Amounts in parentheses are based on the fill and soak method of deconning. Otherwise, the mechanical method is assumed.

result of steam generator inspection and repair. Enhanced generator integrity should lower this to about 25 man-rem/year. This represents a reduction of about 250 man-rem/year and a dose pay-back period of about 9 years. While the projected savings in man-rem is not the prime motivating factor in the decision to replace the H. B. Robinson Unit 2 steam generators, it is a positive benefit from a radiological standpoint.

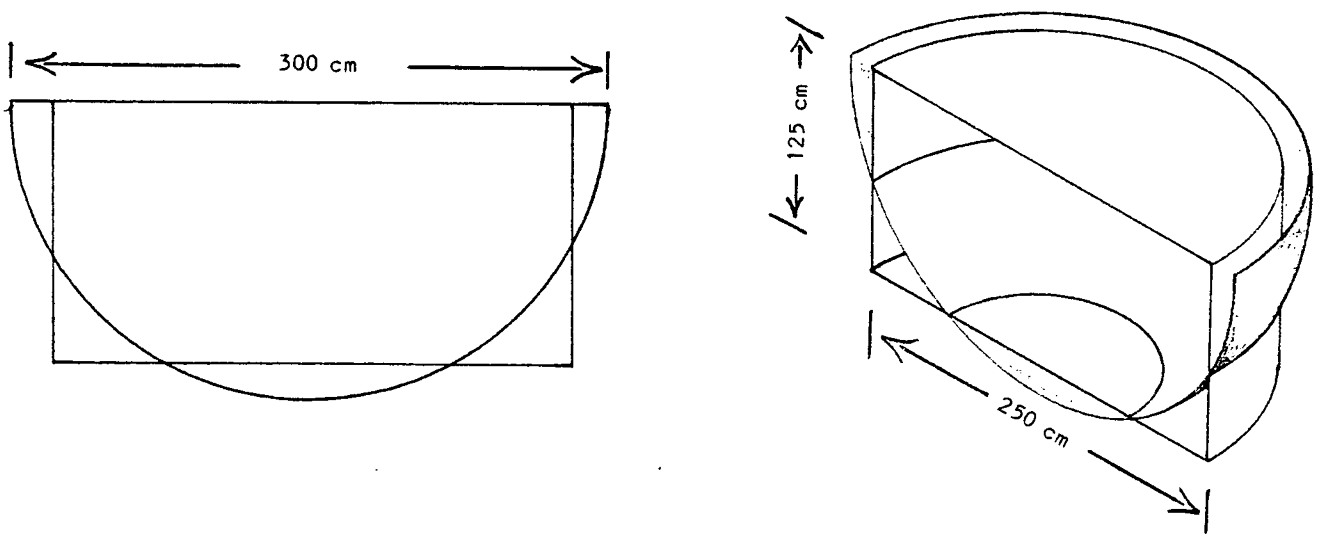
3.4.8.2 System Nuclide Inventory

In addition to the man-rem assessment for on-site operating personnel, an off-site dose projection was performed. An estimate of activity released is directly related to the activity on site and its treatment prior to release. The major on-site nuclide sources consist of deposition on the steam generator primary sides, the general area surface contaminants, and the reactor coolant water. Each of these was considered separately.

a) Corrosion Product Deposition on Steam Generator Primary Side - To establish an inventory of corrosion products on the primary side of a typical H. B. Robinson steam generator, it is necessary to know the isotopic ratios of the gamma emitting nuclides present and the exposure rate inside the channel head cavity. This information was obtained from the spectral analysis of smear samples taken on the steam generator primary side and from direct readings made inside the channel head using a model 6112 Teletector. The analytical results along with activity levels 30 days after shutdown are shown in Table 3.4-3. Typical probe readings were ~ 10 R/hr.

To calculate nuclide inventory, it is assumed that the isotopes on the smear were present in the same ratios as on the steam generator surface and that the corrosion products were uniformly deposited on the channel head bowl, divider plate, and tube sheet.

Actual calculations were done by approximating the spherical channel head surface with a cylindrical surface as shown in the figure below.



For the general area decon, a decontamination factor of 10 is assumed. Therefore, 12 curies from the general area is processed through the rad-waste system which has a decontamination factor of 10^4. Thus a total of 1.2×10^{-3} curies of activation and mixed fission products are released to the public from the decon of the general area. Total liquid effluent releases are presented in Table 3.4-9 and 3.4-9a.

For comparison, Table 3.4-10 gives the measured airborne and liquid releases during a typical operating month.

3.4.8.4 Off-Site Dose Projections

The off-site radiological impact of an airborne release can be evaluated by calculating the dose equivalent to both the critical organ (lung) and the whole body of a teenager (the critical age group). The calculation is performed at the most limiting site boundary location assuming a ground level release of 3.48 μCi derived in the previous section. Under these conditions the lung dose and whole body dose are 8.1×10^{-4} mRem and 1.8×10^{-6} mRem respectively.

The fundamental equation used in determining off-site doses is

$$D = \chi/Q \cdot Q \cdot DCF$$

Where D is the dose in rem, χ/Q is the atmospheric dispersion factor derived from the Gaussian Diffusion Model, Q is the source term, and DCF is the dose conversion factor.

3.4.8.5 Conclusions

From the foregoing examination of facilities, programs, provisions, and projections, it is concluded that Carolina Power & Light Company is adequately prepared to deal effectively with the variety of health physics activities that are anticipated in a project of this magnitude.

The radiological impact of the project is such that the overall expenditure of man-rem over the next nine years will be reduced.

Finally, radiological releases to the environment and their concomitant off-site doses are less than those observed during periods of normal operation.

3.5 DISPOSITION OF STEAM GENERATOR LOWER ASSEMBLIES (SGLA)

The disposition of the SGLA is a separate operation of the S/G repair effort and, thus, is assessed separately. Five disposal options are considered within this section for the disposition of the steam generators. A description of each option including the costs, task descriptions, man-hours, man-rem, radioactive effluents, design specifications of buildings and structures, and health physics considerations is presented for each of the five options. This information is presented in this format so that the advantages and disadvantages can be viewed and weighed for each option. Thus, the optimum cost/man-rem option is more apparent.

3.5.3 ONSITE STORAGE

An on-site storage building will house the three SGLA indefinitely. The final disposition will be decided upon at the time of decommissioning of Unit 2. The building will be completely enclosed with adequate wall thickness to reduce the exposure rate at the surface(s) of the building to less than 1 mrem/hr. The building will be provided with (1) access ports so that periodic exposure rates can be taken remotely and (2) a passive ventilation system to allow for the expansion and contraction of air within the vault. The SGLA openings will be sealed prior to removal from the RCB. This will prevent the release of radioactivity during transfer and storage and will preclude the need for an active ventilation system and periodic air sampling and smearing inside the storage building.

3.5.4 OFFSITE SHIPMENT AND DISPOSAL

The off-site handling, transport, and burial operation is identical for each SGLA. The SGLA is removed from the RCB equipment hatch and loaded onto a railcar or semitrailer. The SGLA is transported to a temporary laydown area and unloaded onto a saddle. The SGLA is then loaded into the bottom half of a shipping cask. The cask will either be secured to a special truck-trailer or a railroad flatcar. The top half of the cask will be lowered into place, sealed, and secured. The cask and SGLA will then be transported to the burial site. At the site the cask will be opened and the SGLA off-loaded and placed into a burial trench. The shipping cask will then be returned to the plant and this cycle will be repeated for the second and third SGLA.

3.5.4.1 Cask Description

The cask is cylindrical in shape and is made of 2 1/2" carbon steel (ASM-A 516, grade 70). The two welded end plates are made of 2 3/4" steel, reinforced by steel ribs.

The cask is composed of two halves, split lengthwise at the centerline. Within the lower half of the cask are two saddles, 24 feet apart, to support the steam generator. When a SGLA is lowered inside the bottom half of the cask, two tie-down straps secure the SGLA to the cask, then the top half is lowered to close the cask. The centerline joint is sealed with an elastomer gasket on a 6" x 2 1/2" bolted flange. One hundred and twelve (112) high-strength bolts, 2 inches in diameter, are used to secure the top half of the cask to the bottom.

The bottom half of the cask is welded to two external saddles (placed directly underneath the two saddles inside the cask). The external saddles are secured to the trailer or railcar.

The cask is designed to meet stringent design criteria for such parameters as load resistance, pressure, temperature, vibration, and penetration. The NRC has issued a Certificate of Compliance, Number 9144, for this cask.

3.5.4.2 Burial

All but one of the options would bury the SGLA shortly after removal from the RCB. The SGLA will be buried in one of two low-level waste sites, either at the Barnwell, South Carolina site or Richland, Washington site. The SGLA will be buried the same way as other low-level radioactive material is buried, the only exception being that a special trench ramp is constructed specifically for placement of the SGLA. All burial operations will be in compliance with the specific burial site license criteria.

3.5.4.3 Transportation Route(s)

The modes and routes and transportation will vary depending upon the disposal option chosen. In general all land travel will be provided by truck and/or railcar and all water travel by barge.

If Option 3 is chosen, all transportation will be by use of a special tractor-trailer arrangement for hauling from the RCB to the storage vault. No shipping cask will be needed.

For all four of the other options, the mode and route of transportation will depend on the destination of the SGLA. If the SGLA is buried in South Carolina then the SGLA or parts of the SGLA will be loaded into casks and transported via special tractor-trailers and/or railcars. If the SGLA is disposed of in the state of Washington, in addition to the special tractor-trailer and/or railcar transport, an ocean-going tug will make the trek from South Carolina to Washington via the Atlantic and Pacific oceans.

3.5.5 DECONTAMINATION

As previously stated in Section 3.4, three methods for deconning the S/G channel head and divider plate are being investigated. However, when consideration is given to deconning the tube sheet and tubes in place, all but the chemical fill and soak method can be excluded.

Two types of chemical fill and soak methods exist. One is a soft chemical cleaning process with expected DF of 5-10, and the other is a hard chemical process with possible DF of 20-200.

The contamination in the S/G is primarily made up of activation products which have bonded with the stainless steel and inconel to form a tenacious film called magnetite. The removal of this film is difficult and requires the use of special deconning fluids. The objectives of the decon is to remove the contamination so that the exposure from handling the SGLA will be lessened and the SGLA may possibly be shipped without a cask. Although this method is very effective, the surface of the channel head must be left unharmed so that it can be reused and the benefit of lower man-rem and handling costs of a deconned SGLA must be weighed against the man-rem and disposal cost of the contamination removed from the SGLA.

3.5.9 HP SURVEILLANCE

The degree and type of health physics coverage is different for the various options. Options 1-3 leave the steam generator intact and thus pose only an external radiation exposure hazard. Options 4 and 5 involve the cutting of contaminated tubes and thus would pose a contamination and airborne hazard in addition to much higher external radiation exposure. All five of the options will require preplanning for deconning and fixing or preventing the spread of contamination from the external surface of the SGLA.

The ALARA principle will be put into practice and healthe physics coverage will follow the same practices as specified in Section 3.4.1 for the actual S/G replacement work.

The use of enclosed work containments to control contamination and minimize the release of airborne radioactivity is planned if either Option 4 or 5 are chosen. All enclosures used for this purpose will employ a ventilation system fitted with HEPA filters.

3.5.10 CONCLUSIONS

Table 3.5-1 summarizes the projected consequences for all the options. Based on the findings of this comparison study, Carolina Power & Light Company will proceed with one of two options--either Option 1, immediate, intact off-site shipment without decontamination, or Option 3, long-term intact on-site storage. Both of these options present the best overall costs and man-rem expenditures realtive to all other possible options. Options 4 and 5 are excluded because of the costs of cutting up the SGLA and the much higher man-rem expenditures associated with the cut-up operation.

Option 2 was considered because of the possibility of removing enough contamination to preclude the use of a shipping cask and reduce the man-rem from handling and transporting the SGLA. However, upon evaluation it was determined that no matter how effective the decontamination process is, 15 percent of the tubes cannot be deconned since they are plugged and thus a shipping cask will still be required according to the 10 CFR 71 requirements. Also, the man-rem to decon and process the waste from the SGLA plus the man-rem from handling the decontaminated SGLA is the same as handling the SGLA without decontamination.

The potential problems of chemical deconning (i.e., spills, integrity of reusable parts, and disposal problems) create a great deal of uncertainty about this option. For these reasons, Option 2 was also excluded.

3.6 PLANT SECURITY

The provisions of Chapter 9 of the HBR2 Industrial Security Plan, which require that the level of security provided during major maintenance operations not result in an increased likelihood of an act of radiological sabotage, will be observed. If necessary, a revision to the existing security plan will be developed and specific procedures will be developed which will address the security aspects of the work being performed. If the regulations in effect at the time of the outage permit, and appropriate approvals are obtained, selected equipment and or areas which had been considered to be

TABLE 3.4-3

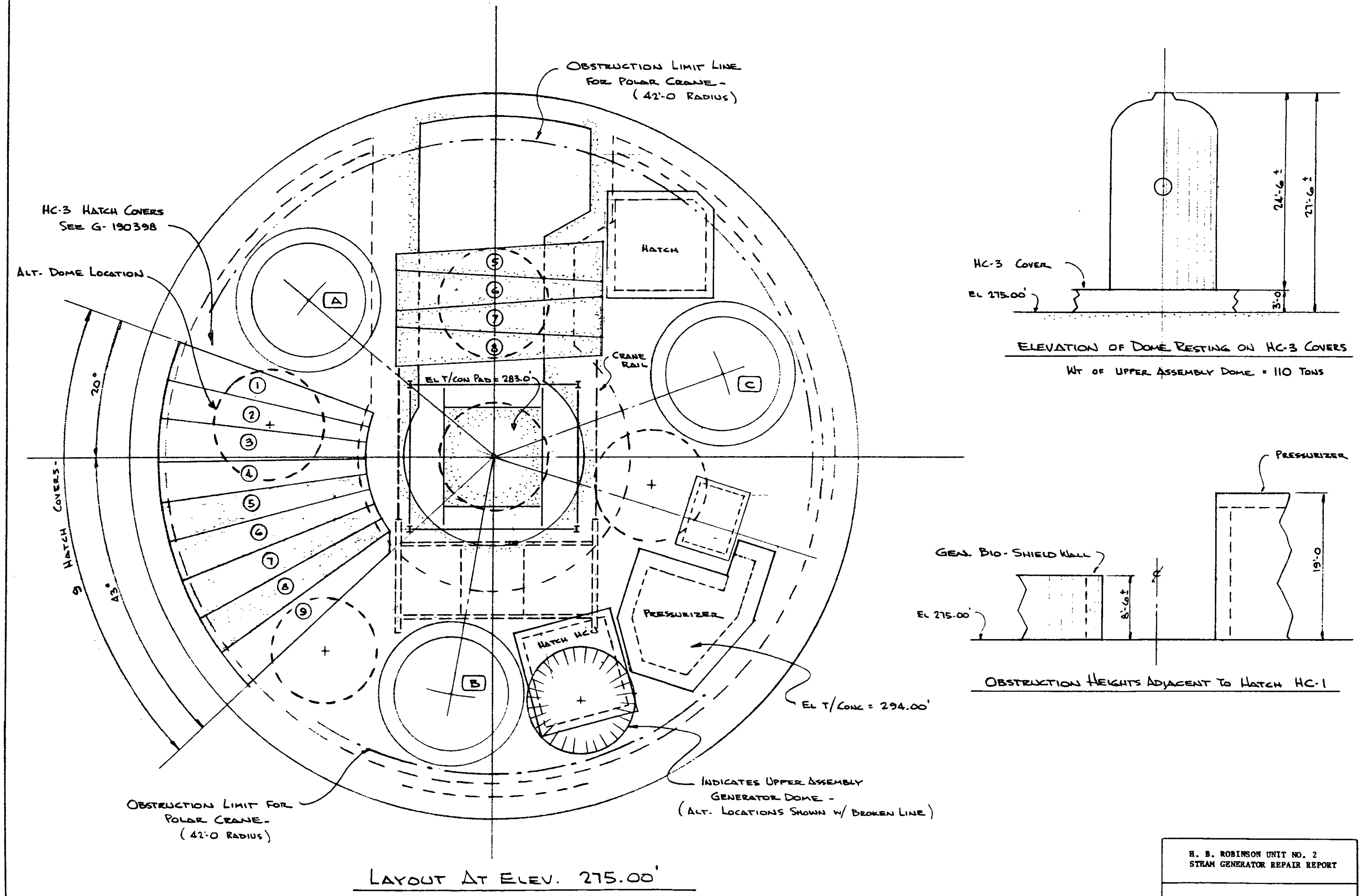
ANALYSIS OF CORROSION PRODUCTS ON PRIMARY SIDE OF CHANNEL HEAD

			At Time of Analysis		30 Days After Shutdown	
Nuclide	Half-Life (da)	$\Gamma j \frac{R}{hr \cdot \mu Ci}$	μCi	%	μCi	%
Cr-51	27.8	1.6E-4	1.843E-3	0.6	2.23E-2	4.43
Mn-54	312.5	4.7E-3	3.399E-3	1.1	4.24E-3	0.84
Co-57	270.0	9.0E-4	3.394E-4	0.1	4.39E-4	0.1
Co-58	71.3	5.5E-3	9.868E-2	32.0	2.61E-1	52.0
Co-60	1919.9	1.3E-2	2.030E-1	66.0	2.10E-1	41.0
Nb-95	35.2	4.2E-3	6.476E-4	0.2	4.65E-3	1.0
Sn-113	115.3	1.7E-3	2.135E-4	0.1	3.89E-4	0.1
		Totals	.308	100%	.503	100%

TABLE 3.4-10

TYPICAL MONTHLY EFFLUENT RELEASES

CLASS	NUCLIDE	HALF-LIFE	LIQUID RELEASES (Ci)	GASEOUS RELEASES (Ci)
Fission Gases	Xe-133	5.29D	0.00E+00	1.03E+01
	Xe-133m	2.26D	----	8.18E+00
	Xe-135	9.10H	4.90E-04	0.00E+00
	Xe-135m	15.60M	2.11E-03	----
Activation Gases	Ar-41	1.83H	1.71E-03	7.92E+00
Fission Products	Cs-137	30.20Y	----	----
	I-131	8.06D	3.89E-04	1.97E-06
	I-133	20.30H	2.32E+03	5.53E-06
	I-135	6.70H	----	0.00E+00
	Ru-103	39.80D	3.54E-06	----
Activation Products	Co-58	71.4D	0.00E+00	----
	Co-60	5.26Y	1.52E-04	5.36E-06
	Na-24	15.03	1.06E+00	0.00E+00
Tritium	H-3	12.33Y	7.59E+00	0.00E00



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MAJOR COMPONENT LAYDOWN

FIGURE 3.0-3

5.0 SAFETY EVALUATION

5.1 FSAR EVALUATIONS

5.1.1 INTRODUCTION

The purpose of this section is to evaluate the impact, if any, of the repaired steam generators on the accident analysis transients for HBR2. Under the guidelines specified in 10 CFR 50.59 such an evaluation is required to verify that no unreviewed safety concerns or changes to the Technical Specifications occur. This section provides a qualitative discussion of the effect on the accident analysis of steam generator parameter changes resulting from steam generator repair.

The relevant plant operating parameters and steam generator design parameters have been compared in Table 2.3-1 and in Section 5.1.2 for the original and repaired steam generators. While incorporating design modifications that will improve the flow distribution, the tube bundle accessibility and reduce secondary side corrosion, the repaired steam generators continue to match the design performance of the original steam generators. It may be noted from Table 2.3-1 and Section 5.1.2 that there is very little change in plant operating parameters in repairing the steam generators. It is, therefore, to be anticipated that the impact on the accident analyses will be insignificant. The results of the accident evaluation show that the repair of the steam generators resulting in physically and functionally similar units will not result in any adverse changes in the plant operating conditions used in the FSAR and later reanalyses, and, therefore, the analyses presented in the FSAR and later reanalyses are still valid. This section establishes that no unreviewed safety concerns exist due to operation with the repaired HBR2 steam generators.

5.1.2 NON - LOCA ACCIDENTS

The purpose of this section is to identify how the changes in design between the original and replacement steam generators could potentially affect the transients and accidents analyzed in Chapter 15 of the H. B. Robinson Updated FSAR. The replacement steam generators (SG) differ from the original SG in the following parameters that are of signifigance in the safety analyses.

a) There are 46 fewer tubes or 1.4% (3,214 vs 3,260).

b) Heat transfer area is 963 ft^2/SG less or 2.2% (44,430 vs 43,467).

c) Primary volume is reduced by 9 ft^3.

d) Secondary no load mass is 3,000 lbm/SG more or 2.2% (137,000 vs 134,000).

e) Secondary 100 percent load mass is 1,000 lbm/SG less or 1.1% (91,000 vs 92,000).

c) The crane boom is 100' long, weighing approximately 25,000 pounds and falls through a vertical plane prior to impact.

d) No additional protection, such as crane mats, structural bridging or added fill is considered in the analysis.

Results: Spent Fuel Building - The existing plant configuration precludes the possibility of a crane boom striking the spent fuel building since the distance from the crane to the building is over 125 feet. Therefore, since a falling boom could not possibly strike the spent fuel storage building, potential hazards to the spent fuel and spent fuel building are eliminated. It should be noted, however, that should a boom fall in the direction of the spent fuel storage building, considerable damage would result to the temporary construction facilities servicing the steam generator replacement operation. Administrative controls will be implemented to reduce this potential to within acceptable limits.

Results: Containment and Equipment Hatch - Analysis was conducted for a freefalling crane boom on the containment shell to determine if it could sustain the boom impact of paragraph "c" above, and the probable extent of damage to the concrete. The evaluation has indicated that potential damage to containment shell might be significant. Thus administrative controls will be invoked to prevent these accidents.

5.2.1.3 Postulated Failure of Lifting Frame and Subsequent Drop of Lower Steam Generator Section

Analyses were performed to determine the effect of impact from the steam generator lower assembly and lifting frame failure during transfer of lower assembly from the service platform to the railcar.

Areas affected:

a) Containment Hatch Construction Area

b) Unit 2 Turbine Crane Runway Extension

The following assumptions were made:

a) Railcar was under lifting frame.

b) Lower steam generator drops approximately 14' to the deck of the railcar.

c) Lifting frame topples in southern direction striking turbine building crane runway.

Results of the analyses indicate that no adverse effects would occur to safety related structures since the equipment hatch is protected by structural

members and there are no underground safety related facilities. However, the analyses indicate the consequences of striking the north turbine building crane runway are unacceptable should the turbine crane be located at the west end. Therefore, administrative controls will be established to limit use of the turbine crane on the west end of the turbine building during actual load handling operations of the steam generator lower sections.

5.2.1.4 Overturning of Railcar (Loaded)

Analyses were performed to determine what (if any) adverse affects would occur should a special railcar loaded with a lower steam generator assembly overturn. The following assumptions were made for purposes of these analyses:

a) Multi axle special railcar with bed height 4'-4" above rail.

b) Standard gauge rail.

c) A steam generator lower assembly weight of approximately 195 tons on the car.

d) Worst case turn radius of 160 feet.

Results of the analyses of the existing plant layout and projected travel route indicate that in the unlikely event a loaded railcar were to become unstable and overturn, it would not jeopardize any safety related equipment or structures required to maintain the safe shutdown condition or cool the spent fuel.

Overturning is considered highly unlikely for the following reasons:

a) Rail sidings and spurs in the vicinity of the plant are on level grade.

b) The minimum turning radius will not be less than 160'.

c) Transport speeds will be maintained by administrative procedure below 5 mph.

5.2.1.5 Runaway Railcar

Analyses were performed to determine the effects of a runaway railcar and the potential damage which would be sustained should a car strike the transfer platform at the equipment hatch.

The following assumptions were made for purpose of these analyses:

a) The 203,000 pound railcar was loaded with an approximately 195 ton lower steam generator assembly.

b) The loaded railcar was traveling at 5 mph on level grade.

The results indicate that the equipment hatch would sustain damage that would be unacceptable. Therefore, the following administrative controls will be implemented:

a) A derail device will be installed on the temporary rail spur.

b) Positive restraint will be provided during transport of the railcars (loaded or unloaded).

c) Railcars when not being moved will have their brakes applied and chocking installed between their wheel and the rail.

5.2.1.6 Potential for Damage to Refueling and Primary Water Storage Tank Due to Load Drop or Rigging Incident

All rigging and load handling operations associated with the steam generator replacement including handling the steam generator lower assemblies will be conducted in areas sufficiently removed from the Refueling and Primary Water Storage Tanks. The tank locations are separated from the rigging areas by the auxiliary building, spent fuel building, containment building and open space. See Figure 3.1-1 for the arrangement. Therefore, there is no potential for damage to this safety related equipment or possibility of interrupting make-up water to the spent fuel storage pool due to a load drop or rigging incident during the replacement program. As previously discussed, no underground safety related facilities are near the loading/unloading area, or transport route.

7.2 ARRESTING CORROSION

Tube failures/degradation occurring in the H. B. Robinson steam generators can be categorized as follows:

Phosphate Wastage (Thinning)

This is typically restricted to the central region of the generator and at or just above the top of the tubesheet. The data evaluated to date, up through the 1979 refueling outage eddy current inspection, indicated that the degradation rate had leveled off and might decrease.

Crevice Cracking

Deposits in the tube to tubesheet crevice cause the formation of intergranular or stress corrosion cracks. Since the first failure attributed to crevice cracking which occurred in September 1979, the failure rate has increased significantly. In April, 1980, 58 tubes were plugged due to crevice cracks. Approximately 50% of these defective tubes would probably not have been identified without the use of multifrequency eddy current examinations. Multifrequency was used at H. B. Robinson for the first time during the March and April 1980 outages. Regardless of the increased sensitivity of the multifrequency probe, the degradation/defects associated with crevice cracking has increased substantially. The exact nature of the corrosion mechanism is not known. By reducing T_{hot} this form of corrosion has been slowed.

Pitting Below the First Support Plate

A pitting phenomenon was identified during the April 1980 inspections at locations where signals attributed to the O.D. copper deposits had been noted in the past. The use of multifrequency eddy current equipment made the defect detection possible. The exact nature of the corrosion mechanism is not known and is not progressing.

Wastage Above the Top of the Tubesheet to the First Support Plate

Isolated occurrences of wastage in this region have been observed in the past. The April 1980 inspection revealed that a small number of tubes experienced rapid degradation in this region. The corrosion mechanism is unknown. By reducing the reactor coolant temperature this phenomenon seems to have been arrested.

U-Bend Failures

Degradation in the tube U-bends, which was not attributed to arc strikes during manufacture or located in the hard regions only, was first identified in March 1980. This degradation has been identified by Westinghouse as phosphate wastage and since we no longer operate at 2300 MWT, this problem seems to be dormant.

Denting

The formation of corrosion products in the tube to support plate and tube to tubesheet annulus, as a result of support plate and tubesheet corrosion,

causes deformation of the tube wall (denting). The eddy current data indicated that denting is still slowly occurring. Both the size of existing dents and the number of dents is increasing. To date no plugged tubes have been attributed to this problem.

Wastage At or Just Above the Tube Support Plates

This degradation was first observed in March 1980. Some of this degradation may have been occurring in prior years but could not be identified without multifrequency eddy current equipment.

Two pivotal factors necessary to cause tube degradation are the existence of crevices wherein chemicals can hide and corrosion products can be confined and introduction of foreign material (i.e., oxygen ingress, condenser leaks).

These causal factors can be eliminated by current state-of-the-art designs, which is the approach followed in repair by utilizing new steam generator lower assemblies. The new tube support plate material has a corrosion product of a volume essentially equal to that of the parent material, the fully rolled tube eliminates the tube-to-tube sheet crevice, and the quatrefoil tube support plate (TSP) minimizes the extent of areas of close tube to TSP clearance and allows for higher sweeping velocities between the tube and TSP which minimizes steam formation and chemical concentrations in this region.

In summary, for plants experiencing appreciable corrosion, incorporation of state-of-the-art designs and EPRI chemistry guidelines appears to currently offer the only viable long term solution to corrosion.

7.3 IN-PLACE TUBE RESTORATION

The feasibility of locally repairing tubes to restore the tubes structural integrity via sleeving has been considered. Sleeving is the insertion of a thin-walled tube insert that is positioned in the vertical section of a tube and hydraulically expanded or brazed in place. This method has been utilized in a current test program to restore tube strength for tubes subject to external thinning. The expanded joint may experience minor leakage from 1 to 10 cc/min. The brazed joint is leak tight.

If the cause of external tube damage is eliminated, then sleeving may offer a means of restoring damaged tubes provided that there is no tube deformation or tube diameter reduction. A close tolerance between tube ID and sleeve OD is required for sleeving.

In summary, it is concluded that in-place tube restoration via sleeving is currently not a viable alternative to the repair since the cause of the corrosion still exists.

7.4 IN-PLACE STEAM GENERATOR REFURBISHMENT

In principle, the methodology exists to refurbish the steam generators in-place. Although much of the technology exists, a comprehensive program of development and testing would be required to provide a basis for cost, time, and personnel exposure comparisons. Based on FP&L evaluations, this repair option was not considered in detail.

There are two principal human resource considerations associated with repair: the duration of the unit outage and man-rem exposure.

A 270-day outage at about a $660,000/day replacement power cost has a worth of about $198,000,000. Clearly then, any emphasis for reducing societal costs should be focused on reducing unit unavailability. This is reinforced due to the fact that man-rem associated with repair will be offset by a substantial reduction in operating man-rem subsequent to repair with a net man-rem societal savings over the lifetime of H. B. Robinson Unit No. 2.

8.0 COST BENEFIT ANALYSIS FOR THE REMOVAL, STORAGE, AND DISPOSITION OF THE LOWER ASSEMBLIES CONSIDERING ALARA

The various alternatives for lower assembly disposal are still under review at the present time. The various alternatives being considered are addressed briefly in Section 3.5 of this report.