DESCRIPTION OF STEAM GENERATOR REPAIR

POINT BEACH NUCLEAR PLANT

UNIT 1

WISCONSIN ELECTRIC POWER COMPANY

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1.0 GENERAL

1.1 Purpose

This document describes the steam generator repair program which will be implemented to restore the performance and reliability of the steam generators installed in Point Beach Nuclear Plant (PBNP), Unit 1. The information contained herein is not intended to supplant the information in the Final Facility Description and Safety Analysis Report (FFDSAR), but supplements the discussion presented therein in the specific areas affected by the repair program and identifies any changes that may result from the repair program.

1.2 Reason for the Action

Unit 1 has experienced secondary side corrosion in a number of tubes in the two steam generators. Various ameliorative measures have been taken to arrest the corrosion, including changes in the secondary water chemistry, plugging degraded tubes, and reduction of operating temperature. Approximately 14 percent of the tubes in each steam generator have been removed from service by plugging. As a result of reduced operating temperature, Unit 1 is currently operating at less than 80 percent of full power.

To increase availability and reliability, and to return to full-power operation, it is appropriate to replace both steam generators in Unit 1.

1.3 Scope of Repair Activities

The overall approach to the repair of the steam generators will be to completely replace the steam generator lower assembly, i.e., that portion of the steam generator below the upper shell, and to refurbish moisture separation equipment in the upper shell. The inlet and outlet reactor coolant piping, the steam line piping and feedwater piping will be cut and sections will be removed. The steam generator shells will be cut at the transition cone and the steam generator upper shell assemblies will be lifted off and placed in a storage-work location in the containment. The upper assemblies will be refurbished for continued service. The lower assemblies will be lifted from their supports and transported out of the containment through the equipment hatch. The replacement assemblies will be transported and installed in a similar manner. The refurbished upper and new lower assemblies will be welded together and the piping will be reconnected. Section 3 provides a detailed description of the repair activities.

1.4 Schedule

It is expected that Unit 1 will be out of service for approximately six months to complete the steam generator repairs. These repairs are currently scheduled to begin October 1, 1983.

1.5 Implementation of Repair Program

The repair program will be completed in accordance with the provisions of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), 1977 Edition, including Addenda through Summer 1981.

The guidelines of Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposure at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable", Revision 2, will be considered in the preparation and implementation of the repair program.

1.6 Project Organization

A special Point Beach project management organization has been established for the repair project by Westinghouse Electric Corporation. This organization has responsibility for the technical direction for design and engineering, as well as the Westinghouse repair activities at the site. The basic project organization consists of a Program Manager, Project Engineering Manager, Resident Operations Managers, and Site Contract and Administration Manager.

The Project Engineering Manager issues design work packages to cover each basic work activity or phase of the repair effort. These packages will be reviewed by Westinghouse and Wisconsin Electric Power Company (WE) prior to implementation.

The Resident Operations Managers are responsible for implementing the design work packages issued for the project and coordinating this activity with other site activities. They will be assisted by personnel familiar with plant operations and construction methods. Qualified health physics personnel will provide radiation protection and monitoring services. This will assure coordination of all repair activities with current health physics programs.

The Resident Operations Manager is also responsible for support activities associated with the project, including scheduling, accountability and storage of materials, etc. The Site Contract and Administration Manager is responsible for purchasing, subcontract administration and cost control.

1.7 Quality Assurance Program

WE has the overall responsibility for the Quality Assurance Program for replacement of steam generators in accordance with Appendix H of the FFDSAR. WE will assure that Westinghouse has documented and implemented a Quality Assurance Program commensurate with their scope of work and in accordance with the requirements of 10 CFR 50, Appendix B, and ASME B and PV Code Section XI.

Quality Assurance (QA) and Quality Control functions will be performed on site by Westinghouse and its subcontractors under QA programs approved by WE. WE QA personnel personnel will audit and provide surveillance to the extent necessary to assure that all activities are conducted in accordance with applicable codes, standards and regulations and are in accordance with the WE QA program.

2.0 REPLACEMENT COMPONENT DESIGN

Westinghouse will shop fabricate new steam generator lower assemblies as illustrated in Figure 2.0-1. The design of the lower assemblies will match the design performance of the lower assemblies being replaced. However, several design features that do not alter mechanical performance and FFDSAR parameters are included in the design. These design features will provide improved flow distribution and improved access to the tube bundle, and will reduce the potential for secondary side corrosion. This section discusses the design and manufacture of the lower assemblies.

2.1 Comparison with Existing Component

2.1.1 Parametric Comparison

The steam generators for the Point Beach Nuclear Plant Unit 1, upon completion of the repair, will have physical, mechanical and thermal characteristics consistent with the original design and safety analyses as documented in the FFDSAR.

Design data for the existing and repaired steam generators are presented in Table 2.1-1. The thermal performance data for each steam generator will remain the same as the original steam generators.

Materials used in the fabrication of the replacement lower assemblies will be identical to those used in the original steam generators except where specific design changes have been incorporated or fabrication practice has changed. These changes include the following:

1. Plate material used in the secondary shell formation has been changed to SA-533 Grade A Class 2 from SA-302 Grade B Class 1 as a result of changes in fabrication practices;

2. Support plate material has been changed to SA-240 Type 405 from SA-285 Grade C to minimize corrosion and the potential for denting; and

3. The steam generator tube material for the replacement steam generator assemblies is thermally-treated Inconel 600. The original tube material was mill-annealed Inconel-600.

Material changes due to design improvements will not degrade the physical, mechanical and thermal performance of the steam generators. Further discussion of material changes is provided in Section 2.2. Table 2.1-2 provides comparison of past and present applications of materials.

2.1.2 Physical Compatibility with Existing Steam Generators and Systems

The replacement steam generator lower assemblies are designed to be duplicate physical replacements for the existing units. Outside overall dimensions are the same as are the locations of nozzles and support attachments. Existing interfaces between the steam

generators and plant components and systems are maintained. Dry and wet weights and center of gravity of the steam generators will remain essentially the same; therefore, no changes to the existing supports are necessary.

2.1.3 ASME Code Application

The existing steam generators were built to the 1965 Edition of the ASME Boiler and Pressure Vessel Code (ASME Code), including Addenda through Summer 1966; the replacement steam generator lower assemblies will be designed and fabricated to the latest edition of the ASME Code in effect as of December 1, 1979. The stress analysis will be performed using the 1965 Edition of the ASME Code, including all Addenda through Summer 1966.

2.2 Component Design Improvements

The physical, thermal and hydraulic characteristics of the steam generators will be at least equivalent to those of the original steam generators. Additional design features have been incorporated in the design. These features will increase the operating reliability and reduce the potential for corrosion of the steam generator components. Extensive research, development and testing have been utilized to select design parameters, materials, and component configurations which will minimize the potential for corrosion and enhance the performance of the repaired steam generators.

2.2.1 Design Refinements to Minimize the Potential for Corrosion

2.2.1.1 Increased Circulation Ratio

Circulation ratio is defined as the total tube bundle flow divided by the feedwater flow and is inversely proportional to the steam quality exiting the tube bundle. As the circulation ratio increases, certain characteristics of the steam generator such as lateral velocity across the tubesheet, steam quality, void fraction and number of tubes exposed to low velocities are improved. Low steam quality in the tube bundle reduces the number of tubes exposed to local steam blanketing and also reduces the number of potential areas for concentration of chemical impurities. Higher circulation ratios increase the fluid velocity across the tubesheet to the center of the bundle which reduces the potential for sludge accumulation. Specific design changes, such as the quatrefoil plates (see section 2.2.1.8), modification in the tube bundle size and wrapper to shell distance, influence the circulation ratio.

2.2.1.2 Flow Distribution Baffle

A flow distribution baffle has been provided 23 inches above the tubesheet. This baffle has a cut out center section and oversized drilled tube holes. The baffle plate assists in directing flow across the tubesheet and

up the center of the bundle through the center cut out. The baffle plate cutout is sized to maximize the flow to the center of the bundle and minimize the number of tubes in low-velocity regions. Consistent with this purpose, the baffle plate is also intended to cause any sludge to deposit near the blowdown intake where it can be removed. The flow distribution baffle plate material is ferritic stainless steel. Figure 2.2-1 illustrates the flow distribution baffle.

While the baffle will direct flow toward the center of the bundle, the average velocity around the tubes will be sufficient to minimize sludge deposition. In addition, as noted in section 2.2.3.1, access holes have been provided to allow sludge lancing above and below the baffle plate.

2.2.1.3 Improved Internal Blowdown Design

Maintenance of the secondary side water chemistry is assisted through the use of the blowdown system. Each steam generator is provided with two 2-inch Schedule 40 Inconel internal blowdown pipes. The blowdown nozzles on the steam generator have provisions for connection to 2-1/2 inch existing blowdown piping. The blowdown intake location is coordinated with the baffle plate design so that the maximum intake is located where the greatest amount of sludge may collect The modified blowdown system also allows higher capacity blowdown in comparison with the present blowdown arrangement.

2.2.1.4 Full-Depth Tube Expansion in Tubesheet

Following insertion into the tubesheet hole, tack rolling, welding and gas leak testing, the tubes are hydraulically expanded to the full depth of the tubesheet holes. Full-depth expansion eliminates the tubesheet crevice in which concentration of impurities can occur.

2.2.1.5 Thermally Treated Inconel 600 Tubing

Research by Westinghouse has determined that additional resistance to 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 an improved metallurgical structure, associated with grain boundary precipitate morphology, which provides increased resistance to stress corrosion. Benefits which result from this treatment include additional resistance to stress corrosion cracking in NaOH, additional resistance to intergranular attack in oxygenated environments, additional resistance to intergranular attack by sulphur-containing species and reduction of residual stress imparted by tube processing.

2.2.1.6 Offset Feedwater Distribution

Feedwater distribution within the steam generators is modified so that 80 percent of the flow is directed to the hot leg side of the bundle and 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. 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 than on the cold leg.

2.2.1.7 Corrosion Resistant Support Plate Material

The support plate material has been selected such that the potential for denting of the tubing due to corrosion in the crevice between the tube and the carbon steel tube support plate is significantly reduced. Alternative support plate materials have been evaluated, and SA-240 Type 405 ferritic stainless steel has been selected as the optimum material for this application. This material is ASME Code-approved and is resistant to corrosion by expected operating chemistry conditions in the steam generator. 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 approximately two times the volume of the parent material. Type 405 also has material properties such as machineability and weldability which are comparable to carbon steel. In addition to the tube support plates, the baffle plate (discussed in section 2.2.1.2) is constructed of SA-240 Type 405.

2.2.1.8 Quatrefoil Tube Support Plates

The quatrefoil tube support plate design, illustrated by Figure 2.2-2, consists of four flow lobes and four support lands. The lands provide support to the tube during all operating conditions. This design has a lower pressure drop than the most current circulation hole designs. This low-pressure drop increases the circulation ratio which, when combined with other improvements, translates into higher sweeping velocities and fewer tubes exposed to local steam blanketing at the tubesheet. This design also directs the flow along the tubes which limits steam

formation and chemical concentration at the tube-to-tube support plate intersections. The quatrefoil support plate design results in higher average velocities along the tubes, which should minimize sludge deposition. The combination of higher velocities in the support plate region and corrosion resistant material minimizes the potential for support plate corrosion.

2.2.2 Design Refinements to Improve Performance

In the evolution of steam generator design, as derived from operating experience and ongoing research and development programs, certain modifications and refinements have been incorporated in recent designs to provide improved thermal hydraulic performance. These are included in the Point Beach replacement assemblies and are discussed below. They do not alter previous safety analyses.

2.2.2.1 Flush Tube-to-Tubesheet Weld

The tubes on the replacement lower assemblies are flush with the tubesheet holes and are welded to the tubesheet cladding. Elimination of the protruding tube stub of the original design results in lower entry pressure losses and, therefore, a lower pressure drop in the primary loop. In addition, a potential point of crud buildup is minimized with this design. This is illustrated in Figure 2.2-3.

2.2.2.2 Tube Lane Blocking Device

A portion of the recirculated water existing at the bottom of the wrapper will tend to preferentially channel to the tube lane and bypass the tube array. In order to minimize this tube bundle bypass, a series of plates are installed in the tube lane to block the bypass flow paths. These plates are arranged so that there is minimal interference with sludge lancing operations.

2.2.2.3 Moisture Separator Improvements

The secondary moisture separator external drains will be changed to larger internal drains. The existing primary separator swirl vane barrels will be replaced with a primary moisture separator assembly consisting of 112 modular 7 inch I.D. swirl vane assemblies. These modifications provide improved steam-water separation and lower carryover in the steam to the turbine.

2.2.3 Design Features to Improve Maintenance

Operational and maintenance experience has resulted in certain changes in design which are directed toward improving maintainability of the steam generators. These changes are discussed below and do not alter performance or FFDSAR safety analyses.

2.2.3.1 Access Ports

The replacement lower assemblies are provided with additional access ports. Four 6-inch access ports will be located slightly above the tubesheet, approximately 90 degrees apart, with two located on the tube lane below the baffle plate. Two 6-inch access ports will be located on the tube lane between the baffle plate and the first tube support plate. The addition of these access ports promotes inspection of the tubesheet and baffle plate and provides for sludge lancing above and below the baffle plate.

2.2.3.2 Inspection Port

One 3-inch inspection port is located on the lower shell transition cone at an elevation slightly above the top tube support of the tube bundle. This port is located on the tube lane centerline and provides for inspection of the top support plate and the tubing U-bend.

2.2.3.3 Wet Layup Nozzle

A 2-inch nozzle is added to the upper shell to facilitate the wet layup of the steam generators during extended shutdown periods. The wet layoup nozzle can be used for addition of chemicals during these periods to maintain desired water chemistry in the steam generator. The nozzle can also be used in conjunction with other equipment to circulate water through the steam generator during periods of layup.

2.2.3.4 Primary Shell Drain

A 3/8-inch primary shell drain is included in the channel head to provide complete drainage of the channel head. This drain facilitates maintenance and inspection to be conducted in the channel head.

2.2.3.5 Primary Closure Rings

Closure rings are welded inside the channel head at the base of each primary nozzle so that closure plates can be installed during steam generator maintenance. This design allows the plates to be bolted to the rings for quick installation and removal. Closure plates allow maintenance or inspection to be conducted in the channel head with the reactor cavity flooded and, thus, can reduce outage time.

2.3 Shop Tests and Inspections

The tests and inspections required by the ASME Code, Section III, will be conducted during the fabrication of the steam generator

lower assembly. In addition to these ASME requirements, further tests and inspections will be conducted at the fabrication facility. The primary side of the steam generator will be hydrostatically tested at the shop in accordance with approved procedures. After the tube bundle installation is completed, a gas leak test will be performed to demonstrate the integrity of the tube-to-tubesheet welds.

TABLE 2.1-1

STEAM GENERATOR DESIGN DATA (PER STEAM GENERATOR)

	Original	Repaired
Design Pressure, Reactor Coolant/Steam psig	2485/1085	N.C.*
Reactor Coolant Hydrostatic Test Pressure (tube side), psig	3106	N.C.
Hydrostatic Test Pressure, Shell Side, psig	1356	N.C.
Design Temperature, Reactor Coolant/Steam, °F	650/556	N.C.
Steam Conditions at 100% Load, Outlet Nozzle:		
Steam Flow, lb per hr	3.31×10^6	N.C.
Steam Temperature, °F	521.2	N.C.
Steam Pressure, psia	821	N.C.
Feedwater Temperature at 100% Load, °F	435.7	N.C.
Overall Height, ft-in	63-1.6	N.C.
Shell OD, upper/lower, in.	166/127	N.C.
Shell Thickness, upper/lower, in.	3.5/2.63	N.C.
U-tube OD, in.	0.875	N.C.
Tube Wall Thickness, (nominal) in.	0.050	N.C.
Number of Manways/ID, in.	4/16	N.C.
Number of Handholes/ID, in.	2/6	6/6
Number of Inspection Ports, ID., in.	None	1/3
Number of U-tubes	3260	3214
Tube height (largest U-bend), in.	397.5	N.C.
Total Heat Transfer Surface Area, ft^2	44,430	43,467
Reactor Coolant Water Volume, ft^3	945	925
Reactor Coolant Flow, gpm	89,000	N.C.
Secondary Side Volume, ft^3	4580	4682

TABLE 2.1-1 (Continued)

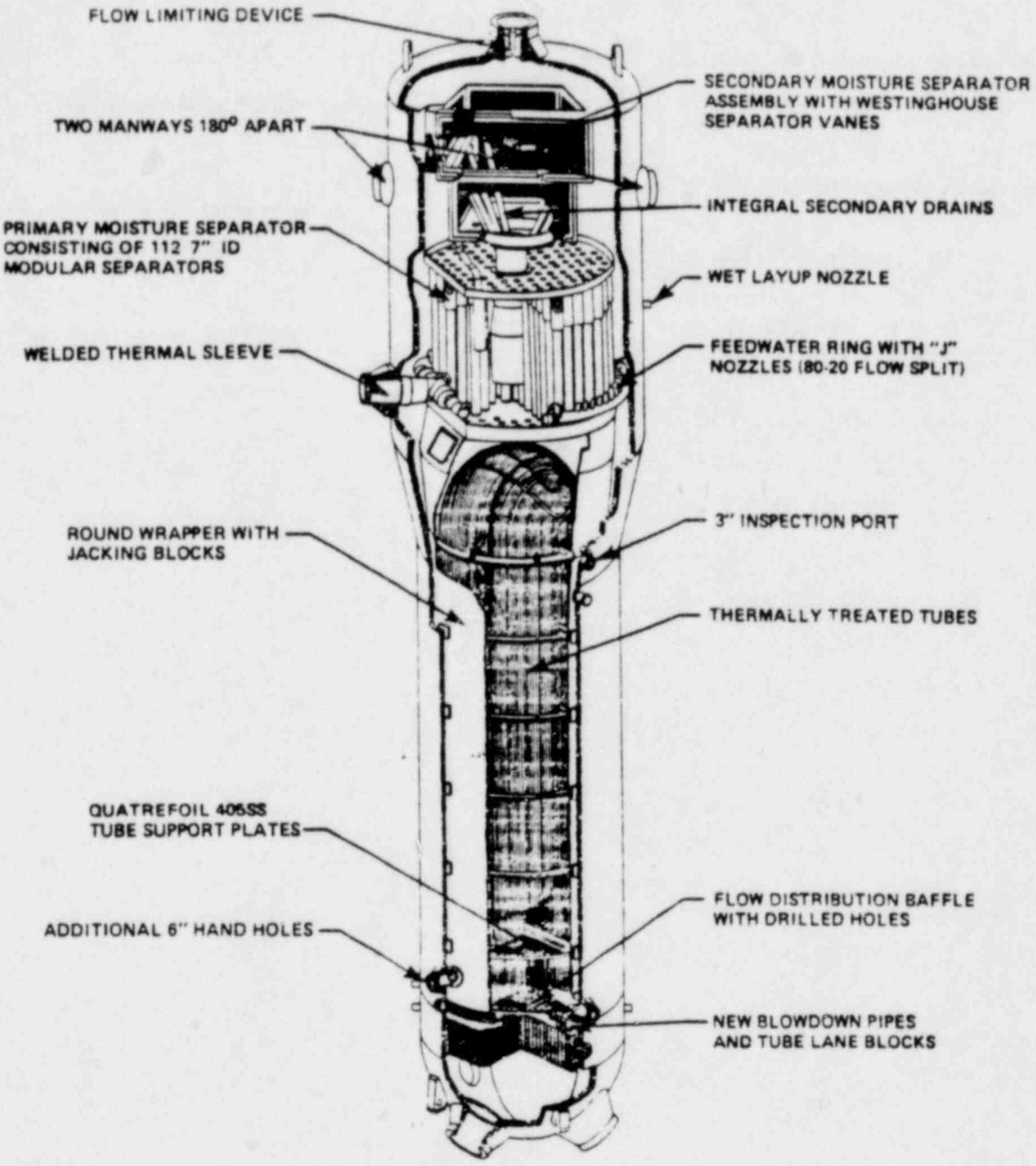
	Original	Repaired
Secondary Side Mass No Load, lbs.	134,000	136,000
Secondary Side Mass 100% Power, lbs	89,000	91,000
Center of Gravity (from the support pads), ft/in.	25-3.6	N.C.

*No change

TABLE 2.1-2

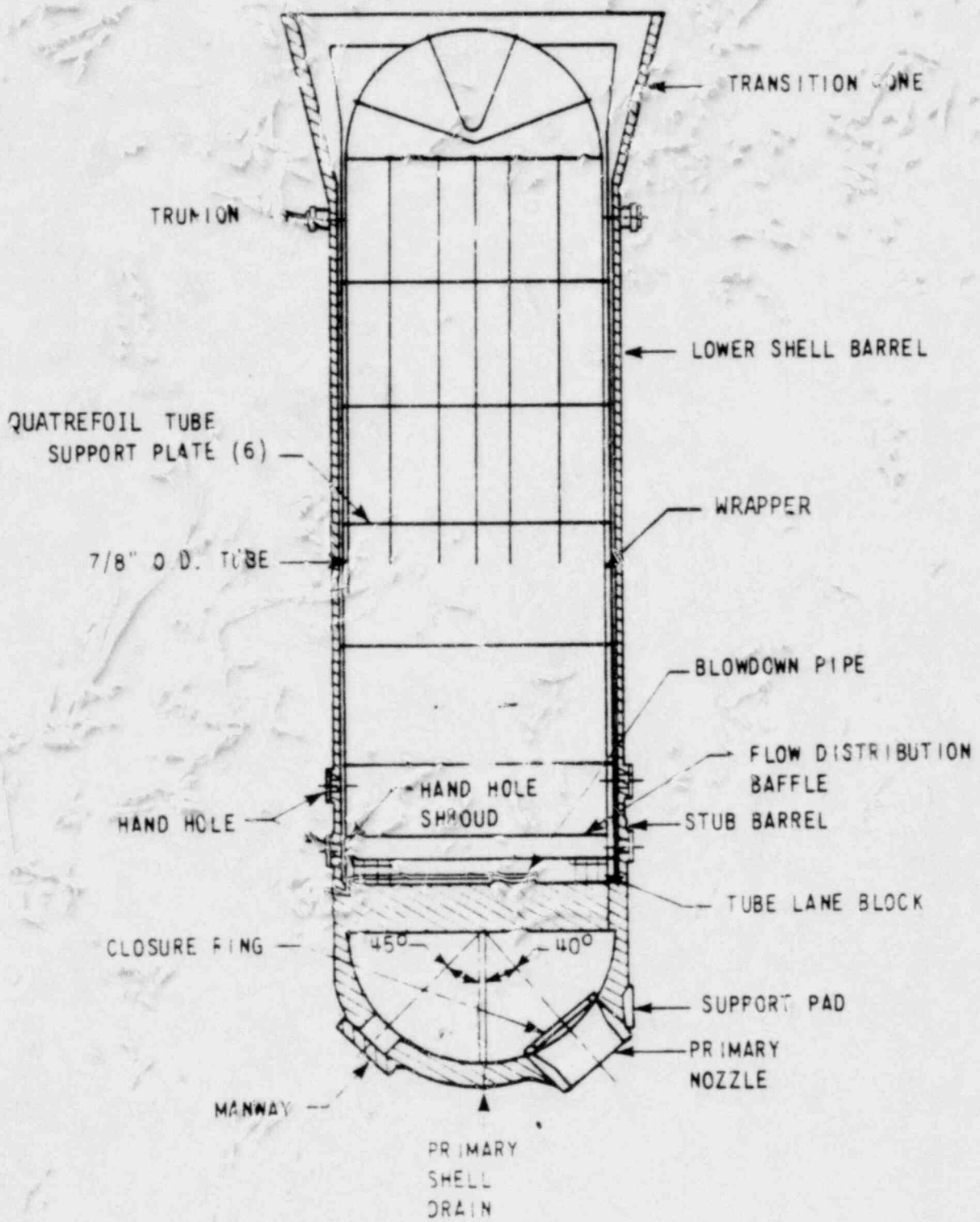
STEAM GENERATOR MATERIALS

	Original	Repaired
Plate (shell courses)	SA-302 Grade B	SA-533 Grade A Class 2
Tube Sheet Forging	SA-336 Code Case 1332	SA-508 Class 2a
Channel Head Casting	SA-216 Grade WC	SA-216 Grade WCC
Support Plates	SA-285 Grade C	SA-240 Type 405
Channel Head Cladding	Stainless Steel, Type 304 or equivalent	Stainless Steel, Type 304 or equivalent
Tubesheet Cladding	Inconel	Inconel Weld Deposit
Tubes	SB-163-61T	SB-163 Special Thermal Treated (Code Case 1484)



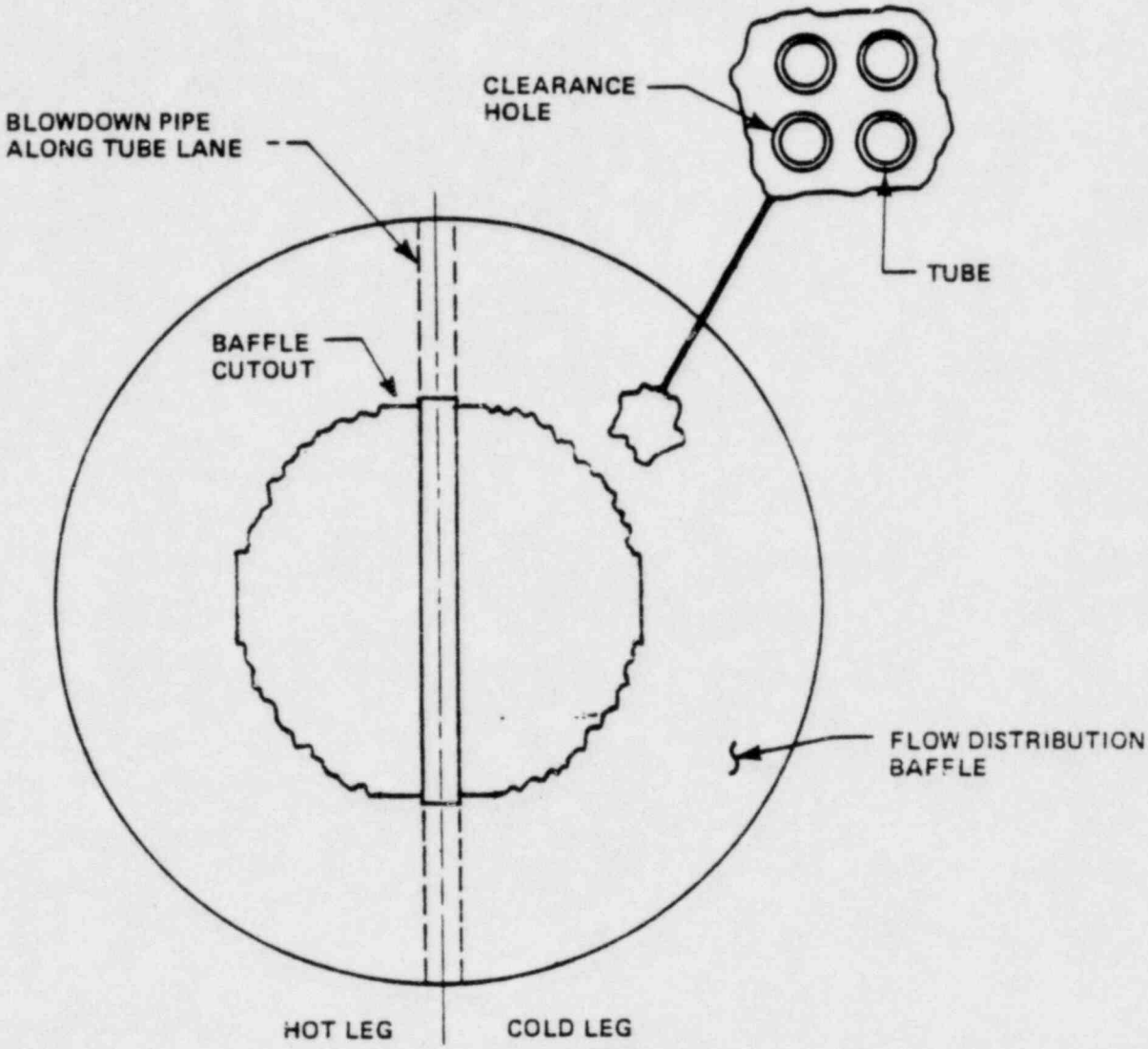
CUTAWAY OF REPAIRED STEAM GENERATOR

FIGURE 2.0-1



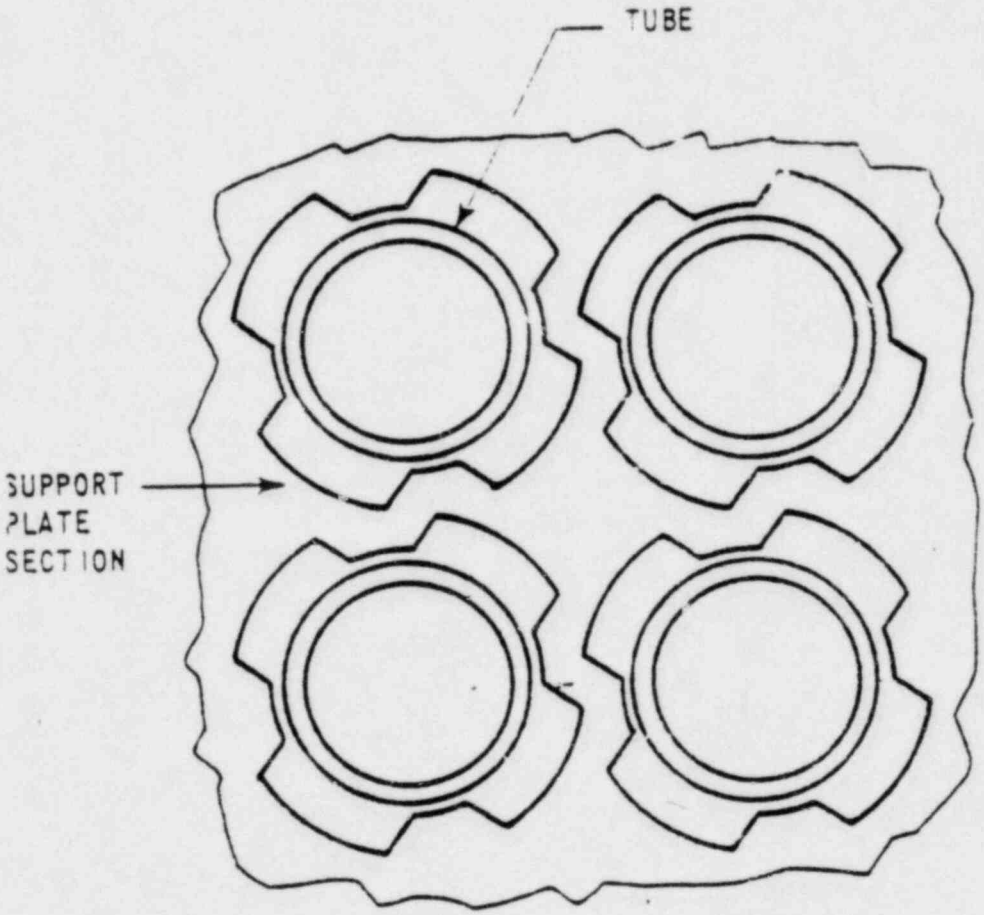
STEAM GENERATOR LOWER ASSEMBLY

FIGURE 2.1-1



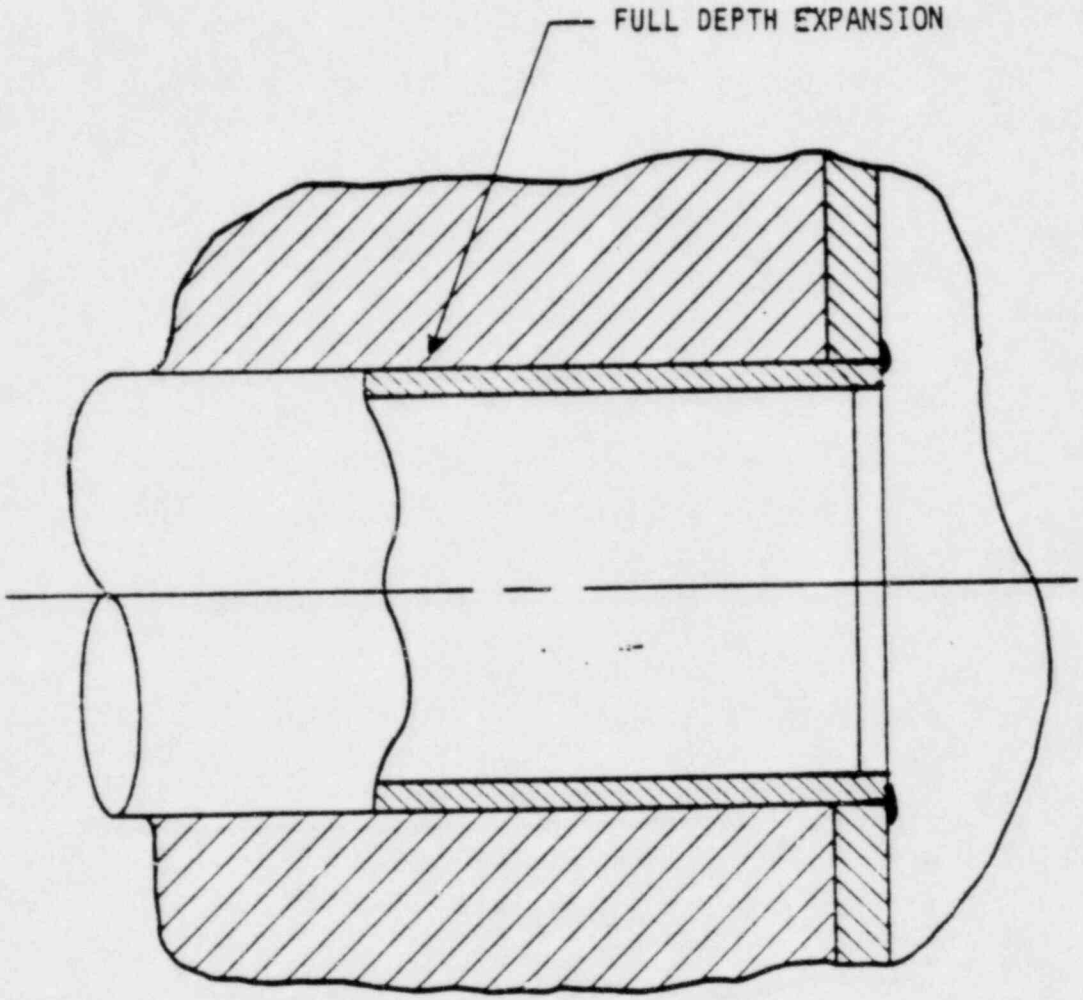
FLOW DISTRIBUTION AND BLOWDOWN

FIGURE 2.2-1



QUATREFOIL TUBE SUPPORT PLATE SCHEMATIC

FIGURE 2.2-2



TUBE-TO-TUBESHEET JUNCTURE

FIGURE 2.2-3

3.0 REMOVAL AND INSTALLATION OF STEAM GENERATORS

3.1 General

This section contains a general description of the removal and installation of the lower steam generator assemblies and associated activities. The discussion is limited to the methodology to be used and the basic removal and installation criteria.

The basic technique which will be used to repair the steam generators will be to cut the currently installed steam generator at the steam drum upper girth weld. The inlet and outlet reactor coolant piping, the steam line piping and feedwater piping will also be cut. The steam generator upper shell assembly will be lifted off and placed in a storage-work location in the containment for refurbishment of moisture separation equipment. The lower assembly will then be lifted from its supports and transported out of the containment through the equipment hatch. The replacement assembly will proceed through the same steps in reverse. The upper and lower assemblies will be welded together in the field. A detailed description of the process is given in following sections.

3.2 Related Activities and Procedures

A number of activities are related to the overall repair program, as follows:

1. The reactor vessel will be completely defueled prior to the repair work. The fuel will be stored in the spent fuel pool for the duration of the repair outage.

2. Access to the containment will be through the present equipment hatch; therefore, no structural changes will be required to the containment structure.

3. The entire repair process will be preplanned. The guidelines contained in Regulatory Guide 8.8, Revision 2 "Information Relevant to Ensuring That Operational Radiation Exposure at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable", will be considered. In keeping with these guidelines, mockups and training will be used extensively to minimize outage time and radiation exposure. Decontamination and other exposure limiting techniques will be used where they offer a significant savings in exposure commensurate with ovreall program objectives. Special scaffolding and other components will be prefabricated to the extent possible to minimize radiation exposure and outage time.

4. The reactor cavity will be covered by structural members to minimize the possibility of impacting the reactor vessel and associated components during the repair program.

5. The repair program will be completed in accordance with the PBNP Quality Assurance Manual and Section XI of the ASME Code, including such items as interaction of repair activities with the unaffected

portions of the plant, design reviews, radiation control procedures, document control, and material acquisitions.

6. The repair activities will be similar to the methods used during original construction of Unit 1 and experience at Surry and Turkey Point. Much of the experience gained during these activities is applicable to the PBNP repair and will be used as appropriate.

7. The environmental effects of the repair program are expected to be insignificant. Reasonable precautions will be exercised to further minimize the potential for environmental impacts.

8. Presently installed plant facilities will be augmented as required to accommodate the additional personnel who will participate in the repair program or to facilitate the actual repair work. These areas include facilities to control radioactive contamination, training and storage facilities, and security facilities.

9. The major portion of the repair program will be performed by a contractor under the direction of Westinghouse personnel. Westinghouse will also provide radiological and personnel exposure controls utilizing the policies and requirements of the WE radiation protection program. The contractor will provide quality control personnel and procedures and Westinghouse will provide quality assurance personnel. The contractor will be required to have an ASME "N" stamp applicable to the work performed.

10. The length of the steam generator repair outage is estimated to be approximately 180 days. This schedule is predicated on working two 10-hour shifts per day, six days per week. The schedule is divided into the following phases:

    a. Pre-shutdown activities;

    b. Shutdown and preparatory activities;

    c. Removal activities;

    d. Installation activities;

    e. Post-installation activities;

    f. Startup activities; and

    g. Post-startup activities.

3.3 Pre-Shutdown Activities

Prior to the shutdown of Unit 1, the repair program will be preplanned and appropriate provisions made for accomplishing each activity required in the repair process. Appropriate procedures, drawings, and instructions will be utilized in the performance of repair activities. Major engineering activities will be completed during this time, as well as establishing

temporary facilities, material acquisition, training of personnel, prefabrication of certain components and completion of items which do not require a shutdown.

The "work package" concept will be used for the repair program whereby individual tasks will be defined and a work package for each task, containing all pertinent information required to complete that task, will be completed.

3.4 Post-Shutdown Activities

Following the shutdown of the unit, certain preparatory activities will be completed prior to the actual removal process, as follows:

1. Establish valve lineups consistent with the requirements of the repair program;

2. Place systems in condition for long term layup, as required;

3. Open equipment hatch and establish access control to work area;

4. Remove reactor pressure vessel head and upper internals and place in storage location;

5. Remove all fuel assemblies from the reactor vessel and store in spent fuel storage pool in the fuel building;

6. Replace upper internals and reactor vessel head;

7. Survey containment work areas and establish radiation zones;

8. Perform local decontamination of work areas to the extent possible and shield areas which cannot be decontaminated;

9. Install cover over the reactor cavity to provide protection to the reactor vessel and associated equipment and to provide a continuous work area. The cover or flooring will be supported by structural members designed to hold the steam generator upper shell and associated equipment;

10. Assemble prefabricated scaffolding to gain access to all work areas;

11. Dismantle the removable block walls in the steam generator cubicles and store;

12. Remove insulation from steam generators, feedwater piping, steam piping, reactor coolant piping, and other components and transport from the containment;

13. Install local control structures, such as tents (if necessary), ducting and temporary filters;

14. Install the steam generator transport system inside the containment and on equipment hatch; and

15. Inspect, test and modify the existing containment polar crane as necessary. The existing polar crane will be used to make all major lifts.

3.5 Removal Activities

Having established appropriate access requirements, radiological controls, installation of temporary facilities to provide access to the work areas and the removal of insulation from the equipment, the actual removal process can commence.

The description given below is applicable to one steam generator. The other steam generator will be removed in a similar manner. The activities for both generators will be performed roughly simultaneously; however, because of availability of the polar crane, the commencement of the activities for each steam generator will be staggered, e.g., the removal process may not begin for steam generator A at the same time it begins for steam generator B.

Where cutting is required, either flame cutting techniques or mechanical techniques may be used.

1. Removal miscellaneous small piping, such as blowdown piping and instrument and controls, to allow removal of the steam generator.

2. Cut steam line piping at the steam nozzle on the upper shell and downstream to allow a section of the piping to be removed so that the upper and lower shells can be lifted. The removed section will be marked for identification and stored for reuse. (See Figure 3.5-1)

3. Cut feedwater piping at its junction with the upper shell and upstream from the junction to allow a section of the piping to be removed so that the upper and lower shell can be removed. (See Figure 3.5-1)

4. Cut and remove reactor coolant inlet and outlet piping. A section of the hot leg (inlet) piping will be removed by cutting the pipe at the steam generator nozzle and at an appropriate point upstream of the nozzle. A section of cold leg (outlet) piping will be removed by cutting the pipe at the steam generator nozzle and upstream of the reactor coolant pump. Figure 3.5-2 shows the portions of the reactor coolant piping which will be removed.

5. Cut the steam generator wrapper to allow lifting of the upper shell.

6. Cut the steam generator shell at the transition cone to upper steam drum girth weld leaving stock on the upper steam drum for final machining.

7. Lift the upper shell of the steam generator with the polar crane and store in the containment.

8. After removal of the upper shell, it will be placed in a convenient location within the containment in the inverted position, i.e., steam nozzle down, where the moisture separation equipment, feedring and

other associated equipment will be removed. The moisture separation equipment will be refurbished.

9. The steam generator lower assembly will be lifted from its supports by the polar crane. The polar crane will be attached to the lower shell by means of cables or straps attached to the two lifting trunnions on either side of the steam generator. A special lifting rig will be used to attach these cables to the crane hook. As shown in Figure 3.5-3, the steam generator will be lifted straight up and out of its supports, moved aside in the vertical position and lowered onto the transportation mechanism. The lower shell assembly will be transported out of the containment through the equipment hatch on a specially designed transport mechanism. The transport mechanism will be a temporary system that will transport the lower shell assemblies efficiently and safely.

10. The steam generator lower shell assembly will be removed from the containment through the equipment hatch. By utilizing this access to the containment, it will not be necessary to modify the containment structure which serves as a pressure boundary. The equipment hatch opening is nominally 15 feet in diameter.

11. Radiological controls will be in effect during all activities. Since the lower steam generators may be a major source of radioactive contamination following the cutting operations, special covering devices will be employed to allow the openings created as a result of cutting to be sealed to minimize radiation exposure and the spread of radioactive contamination. These covering devices will be designed so that they can be quickly and easily installed and to provide the degree of shielding required.

12. During all activities, the containment work areas will be cleaned and decontaminated as required.

13. Following the transport of the steam generator lower assemblies through the equipment hatch, they will be transported to a temporary storage facility on site.

3.6 Installation Activities

Following the removal of both steam generator lower assemblies, the major installation activities will commence. The major steps involved in the installation process are discussed below.

1. Deliver the steam generator lower assemblies by barge or rail to be transferred to a rubber-tired transporter for travel to the site and possible temporary storage.

2. Transport the steam generator lower assemblies to the equipment hatch area for transfer into the containment using the containment transport system.

3. Move each assembly to a designated location within the containment. Upend, lift, and lower assemblies into place in the steam generator supports.

4. Reassemble and/or reinstall the steam generator support system.

5. Install new moisture separation equipment, feedring and other internal components in the upper shell. Prepare mating surface of upper shell for welding to lower assembly.

6. Lift upper steam generator shell into place and align with lower assembly. Temporary positioning devices may be used to facilitate alignment without the use of the polar crane.

7. Weld the upper and lower assemblies together, stress relieve and inspect.

8. Weld the steam generator wrapper to the upper internals and inspect.

9. Install the reactor coolant piping. The installation procedure for this piping is similar to that used during the original installation of the steam generator.

10. Fitup, weld, and inspect the main steam piping.

11. Fitup, weld, and inspect the feedwater piping.

12. Fitup and weld miscellaneous small piping.

13. Install instrumentation and controls.

14. Reassemble removable block shield walls in the steam generator cubicles.

3.7 Post-Installation Activities

Following the completion of the major installation activities, the unit will be restored to a condition for testing and inspection. The following activities will be performed:

1. Perform hydrostatic tests in accordance with Section XI of the ASME Code.

2. Clean affected systems and work areas.

3. Install insulation.

4. Remove scaffolding.

5. Remove cavity cover.

6. Install reactor internals, vessel head and other components.

7. Refuel the reactor.

8. Perform baseline inservice inspection as required on piping, equipment or components, including 100 percent eddy current inspections of steam generator tubing.

9. Remove temporary structures and supports.

3.8 Startup Activities

Upon completion of the repair work, a number of activities are performed to return the unit to power operation. Among these are:

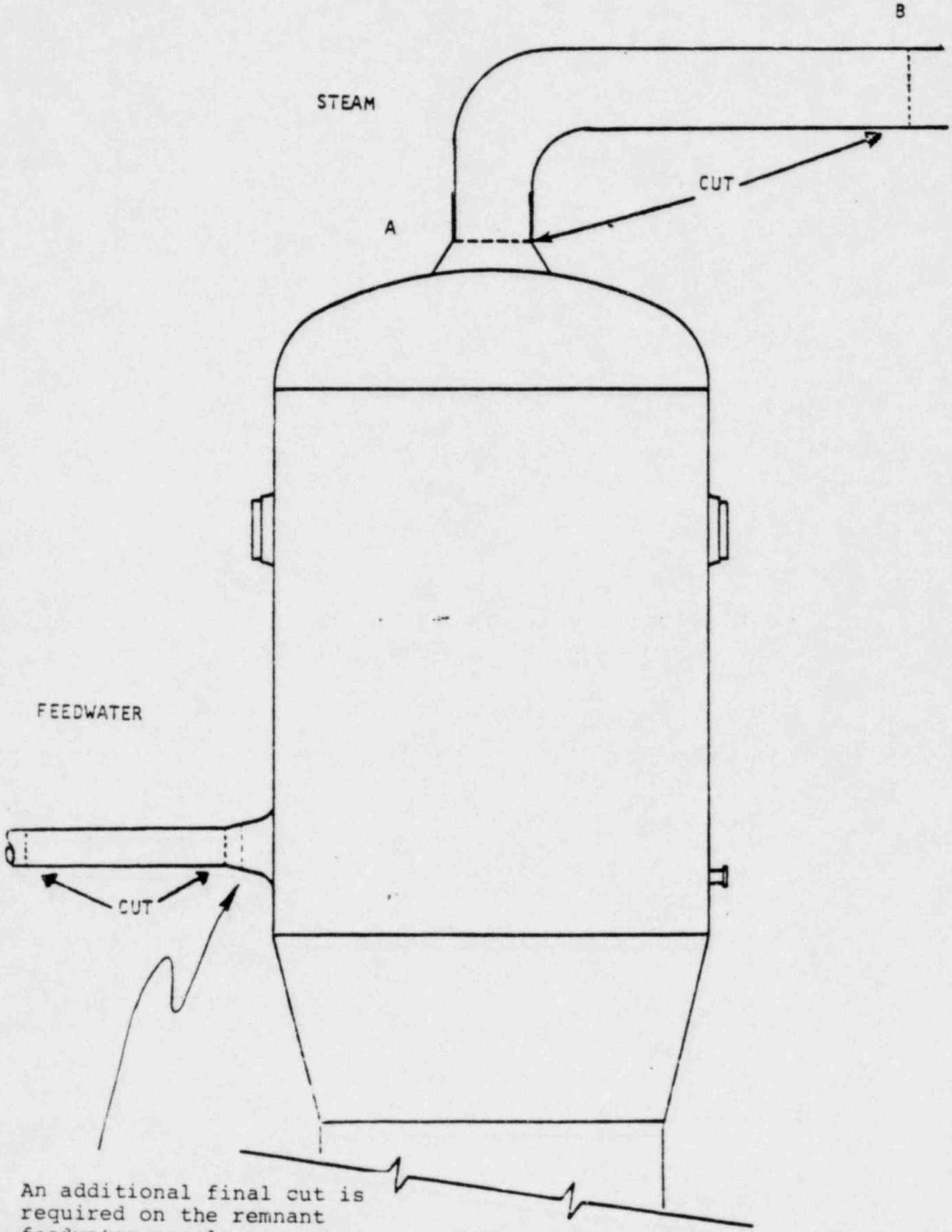
1. Establish valve lineups and system conditions in accordance with established procedures.

2. Perform startup test programs on the systems that were affected by the repair effort or as otherwise required to satisfy test program requirements and the Technical Specifications.

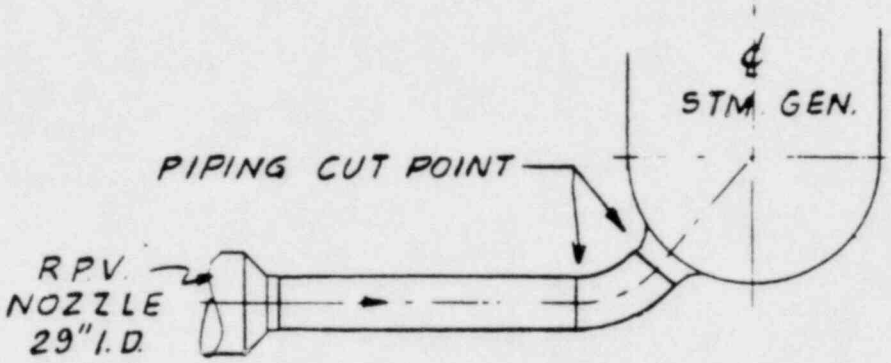
3. Run performance tests and moisture carryover tests to verify thermal hydraulic performance of the steam generators.

FEEDWATER AND STEAM LINE PIPING

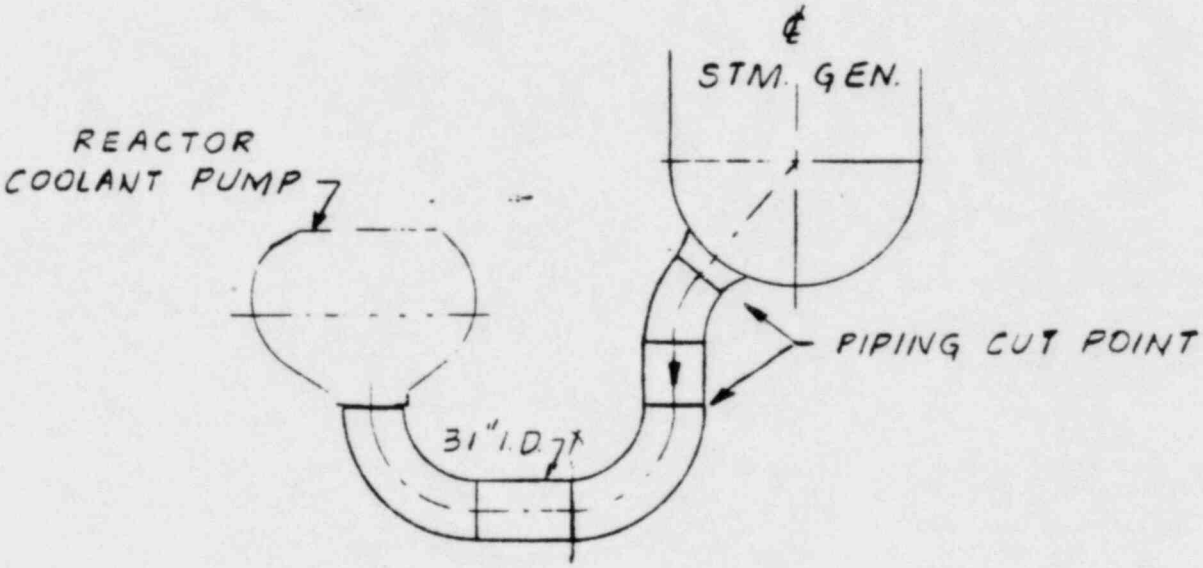
FIGURE 3.5-1



NOTE: An additional final cut is required on the remnant feedwater nozzle.



SECTION
REACTOR COOLANT PIPING
HOT LEG

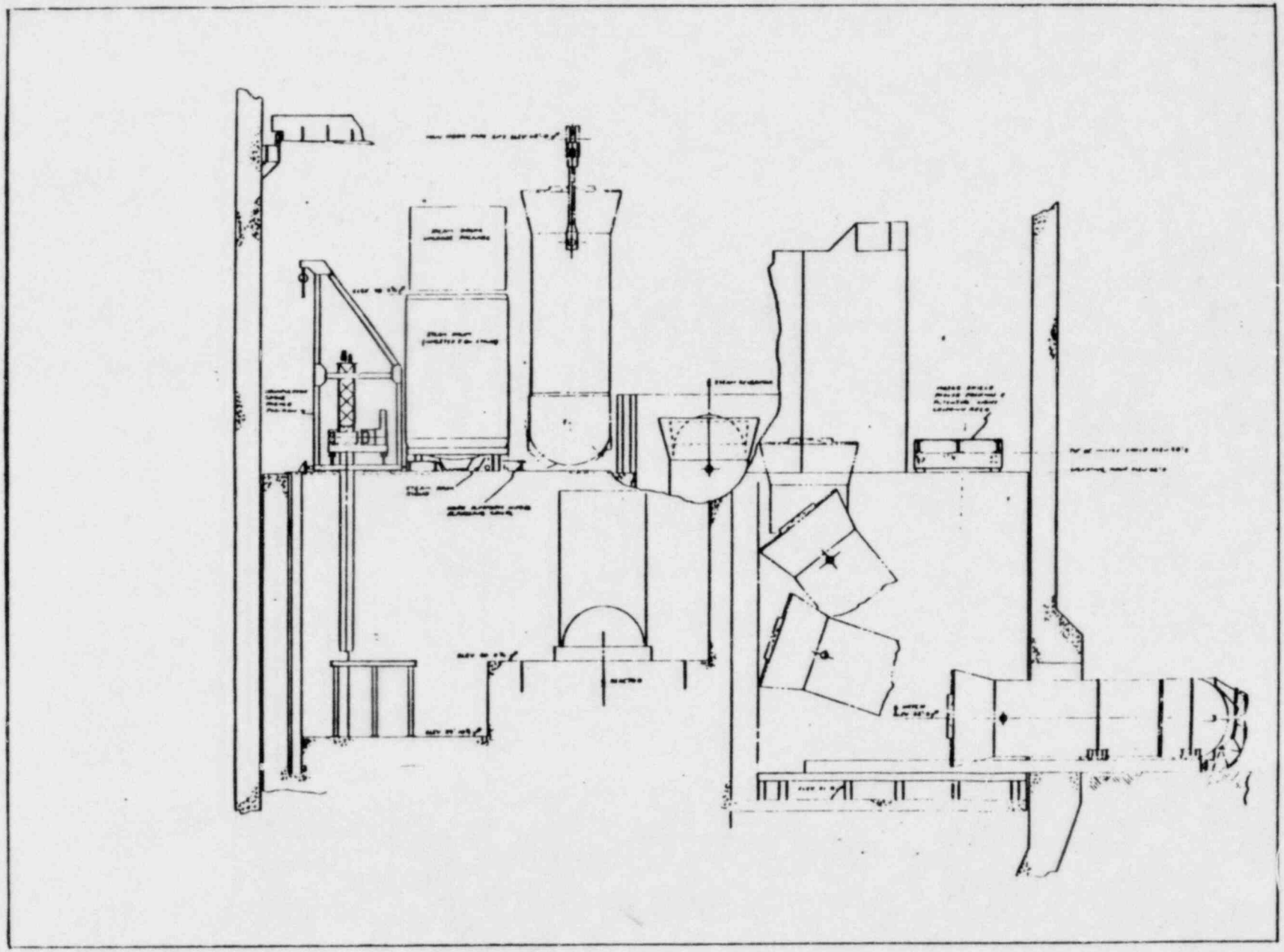


REACTOR COOLANT PIPING
CUT POINTS

FIGURE 3.5-2

Figure 3.5-3

SCHEMATIC OF STEAM GENERATOR LOWER ASSEMBLY
REMOVAL AND INSTALLATION
POINT BEACH NUCLEAR PLANT



4.0 SAFETY CONSIDERATIONS

4.1 Introduction

The purpose of this section is to discuss the safety evaluations which have been performed to date. Based upon these evaluations and experience at other plants where similar steam generator repair work has been performed, Unit 1 will be returned to power for continued operation without any significant adverse effects on the health and safety of the general public or the personnel performing the repair work.

4.2 Comparison of Modified Steam Generators with Existing Design

The modified steam generators will have physical, mechanical, hydraulic, and thermal characteristics compatible with the original design and safety analysis as contained in the FFDSAR. Design data for both the installed steam generators and the refurbished steam generators are presented in Table 2.1-1. The design parameters for the originally installed steam generators and the refurbished units are duplicated with the exception of the following:

1. The number of handholes has been increased to provide additional access to the secondary side of the steam generators. The modified steam generators will have six handholes which are 6 inches in diameter and one 3-inch inspection port slightly above the upper most tube support plate of the tube bundle; and

2. The number of tubes in each modified steam generator will be 3,214 versus the 3,260 tubes which are now installed. The reduction of 46 tubes is required to facilitate the design of the quatrefoil tubesheet and the relocation of the stayrods.

Table 2.1-2 summarizes the construction materials for both the originally installed steam generators and the replacement units. The materials used in the modified steam generators will be similar to those used in the originally installed steam generators except where specific design modifications have been made or a fabrication practice has changed. The following material changes have been made

1. The plate material used in the secondary shell formation has been changed to SA-533, Grade A, Class 2, from SA-302, Grade B, as a result of fabrication practices. The use of a higher grade material provides increased safety margin since it satisfies all requirements and has a higher yield strength.

2. The support plate material has been changed to SA-240, Type 405 (stainless), from SA-285, Grade C (carbon steel), as a result of design changes made to prevent corrosion (discussed elsewhere in this document).

3. The tubing material of both the modified and originally installed steam generators is SB-163; however, the tubing in the modified steam generators will be thermally treated.

These material changes do not affect the safety analyses presented in the FFDSAR.

4.2.1 Physical Compatibility with Existing Steam Generators and Systems

The steam generator lower shell assemblies will be physically similar to the presently installed units, except for the design modifications which have been previously discussed. The overall size and dimensions of the steam generator will remain essentially the same. However, minor and insignificant dimensional changes may exist because of normal manufacturing tolerances and final fitup of the upper and lower shells. The location of nozzles and support attachments will remain the same. The respective dry and wet weights of the new and old steam generators will be approximately the same, and the center of gravity will not be significantly changed. These changes will not significantly affect FFDSAR safety analyses.

4.2.2 ASME Code Application

The presently installed steam generators were designed and constructed to the requirements of the 1965 Edition of the ASME Code, Section III, Summer 1966 Addenda. The refurbished assemblies will be fabricated to the requirements of the latest applicable Edition of the ASME Code in effect as of December 1979. Design of the steam generators will be consistent with the original design of the reactor coolant system, as well as the upper shell assembly of the steam generators. None of the requirements imposed on the replacement assemblies will affect the capability of the steam generators to meet the performance requirements or the transients analyzed in the FFDSAR.

4.3 Accident Analyses

Section 14 of the FFDSAR includes analyses of the following accidents:

1. Uncontrolled rod cluster control assembly (RCCA) withdrawal from a subcritical condition;

2. Uncontrolled RCCA withdrawal at power;

3. RCCA drop;

4. Malposition of the part-length rods;

5. Loss of reactor coolant flow;

6. Chemical and volume control system malfunction;

7. Startup of an inactive reactor coolant loop;

8. Excessive load increase incident;

9. Loss of normal feedwater;

10. Loss of external electrical load;

11. Reduction in feedwater enthalpy incident;

12. Loss of all A.C. power; and

13. Likelihood of turbine-generator unit overspeed.

14. Loss-of-coolant accidents (LOCA)

Evaluations will be performed to verify that the design modifications and improvements in the repaired steam generators do not significantly affect FFDSAR safety analyses for these accidents.

5.0 ENVIRONMENTAL CONSIDERATIONS

5.1 General

This section evaluates environmental effects relevant to the steam generator repair effort and demonstrates that no significant environmental effects are associated with the repair activities. The site preparation, construction, and repair activities will conform with local, state, and federal regulations. Any minor environmental impacts are expected to be temporary and controllable by the use of standard construction practices.

5.2 On-Site Effects

All construction activities and modification of existing buildings associated with the steam generator repair effort will take place within the security fenced area, or in an area immediately adjacent to it north of the plant. The adjacent area was previously modified during construction of the plant. The use of this area minimizes the extent of site preparation required and the potential for environmental impacts.

5.3 Land Use

The repair effort will have minimal impact on existing site layout and plant facilities. Two new facilities, a 16,000-square-foot operations building and a 5,500-square-foot temporary steam generator storage building, will be constructed in the previously modified area adjacent to the plant to the north. A 6,500-square-foot access structure will be constructed adjacent to the Unit 1 containment facade. Approximately four acres of land will be required for construction activities. A parking lot will require about two acres and a laydown area will require about one and one-half acres. The temporary steam generator storage building and the operations building will require about one-half acre. No restriction on the usage of the existing on-site Energy Information Center, recreational boat-launching area, fisherman parking lot, or fishing platform are anticipated due to construction. Less than normal usage of the fishing platform situated on Unit 1 discharge flume and boat-launching area is probable during the outage based on the absence of the warm water discharge from Unit 1 which attracts fish to the area.

No historical, cultural, archaeological sites, or natural landmarks or access thereto will be affected by the proposed construction activities.

5.4 Terrestrial Environment

The construction area to the north of the plant has reverted to grasses, sweet clover, and other weedy plant cover. The area is only utilized minimally, if at all, by the species of fauna known to inhabit the plant site. It is anticipated that whatever species normally use the habitat in the construction area will move to and use other adjacent areas of the plant site once construction activities begin, and other existing populations of wildlife on the plant site will avoid the area until construction activities are completed. Approximately four acres of this low value habitat will be lost.

No displacement of wildlife from other areas of the plant site (i.e., woodlots, small ponds, and stream course areas) due to increased levels of human activity and noise associated with the construction activities is expected to occur.

No impact on rare and endangered species is expected.