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SGRR

PALISADES PLANT

STEAM GENERATOR REPAIR REPORT

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techniques and American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) editions.

1.1.4 SAFETY-RELATED CONSIDERATIONS

To be provided later.

1.1.5 ALARA CONSIDERATIONS

Personnel exposure will be maintained "as low as is reasonably achievable" (ALARA) throughout the steam generator repair program.

Estimates of the exposures to personnel involved in the various repair alternatives have been developed using projections of work activity durations, manpower levels, and expected radiation levels.

1.1.6 OFFSITE RADIOLOGICAL CONSEQUENCES

Radiological evaluations of the gaseous and liquid releases attributable to the steam generator repair have been conducted. The effects of the releases are less than those associated with normal operation of the facility on the basis of the discussion in Section 6.2.2.

1.1.7 UNIQUE ASPECTS OF PROGRAM

As presently contemplated, there are no unique engineering or construction aspects of the Palisades Plant steam generator repair program. The repair program, including the fabrication of replacement units, will utilize conventional nuclear industry manufacturing and construction methods. The shop fabrication of the steam generators will be conducted in accordance with standard shop practices. The closure of the temporary construction opening in the containment will be performed in a manner similar to that used to close the original containment construction opening. The transport and rigging of the steam generator will utilize proven techniques. In short, the repair program will rely on fabrication and construction practices or techniques which have been previously qualified for similar applications.

1.3 10 CFR 50.59 CONSIDERATIONS

To be provided later.

1.4 CONCLUSIONS

To be provided later.

j. Regulatory Guide 1.84, Code Case Acceptability - ASME III Design and Fabrication (August 1977)

k. Regulatory Guide 1.85, Code Case Acceptability - ASME III Materials (August 1977)

2.2 COMPONENT DESIGN IMPROVEMENTS

The replacement steam generator design incorporates the traditional Combustion design features and design improvements that have evolved through several generations of steam generator designs in response to the operational steam generator problems that have occurred in the nuclear industry.

The replacement steam generators will essentially duplicate the physical, thermal, and hydraulic characteristics of the original units while incorporating a combination of features proven in field operation and design improvements to mitigate operational problems.

The heating surface has been selected to provide thermal performance which would match that presently installed and to respond to plant thermal transients in the same manner as does the existing unit. The design will provide improvements in thermal/hydraulics, notably in secondary flow distribution. These improvements are intended to minimize flow stagnation, steam blanketing, and harmful solids accumulations. It is important to avoid harmful solids deposits in contact with heat transfer tubing in the steam generators. Furthermore, flow baffles have been included to minimize solids dropout on the tubesheet. The blowdown arrangements are designed to take advantage of the improved flow distribution, making significant improvements in the effectiveness of blowdown in removing harmful solids deposits.

The tube support system utilizes the traditional Combustion eggcrate tube support, with its low flow resistance, support against vibration and wear, and resistance to tube denting or lateral tube deformation.

The bend region tube support system also uses the standard Combustion approach, with double 90 degree bends and support assemblies of interlocking strips. The design provides positive restraint against vibration and resistance to tube deformations during LOCA, steam line break, and seismic events. The tube support system provides rugged, positive

support while minimizing flow resistances and the possibility of local dryout of steam blanketed regions. Access openings and inspection ports are provided to enable inspection of tubes, tubesheet, and support surfaces within the tube bundle as well as at the periphery of the bundle.

2.2.1 DESIGN FEATURES TO IMPROVE PERFORMANCE

2.2.1.1 Thermal Performance

In order to minimize the effect on plant transient performance, heat transfer tubes of 3/4 inch outside diameter and .042 inch average wall thickness (consistent with Combustion's System 80 design) will be provided in such quantities and lengths on the replacement units that the product of their area (A) and heat transfer coefficient (U) equals the product of the original area and original coefficient, i.e., (UA) new = (UA) original. The total cross-sectional flow area of the heat transfer tubes will be equal to the cross-sectional flow area of the tubes in the original units. The control of these parameters on the replacement units allows the hydraulic impedance to primary flow to essentially correspond with that of the original steam generators.

2.2.1.2 Flow Distribution Baffle

For the replacement steam generators, Combustion will include a flow distribution baffle just above the tubesheet secondary face. The flow baffle assembly shown schematically in Figure 2.2-2 causes the recirculating flow from the downcomer to be directed radially across the tube bundle, maintaining relatively high fluid velocities throughout the tube bundle region. The tube bundle on the replacement units has an open region in the center of the steam generator approximately 42 inches in diameter around the primary stay, where tubes are omitted. The flow baffle causes radial flow to completely penetrate the tube bundle before exhausting into the open region of the tube bundle. Appropriate baffling is included in the divider lane to prevent tube bundle bypass and to ensure maximum velocities at the tubesheet.

While the flow baffle is a perforated plate, Combustion does not anticipate that denting will occur in the flow baffle for the following reasons:

a. The flow baffle is constructed of Type 405 stainless steel, a corrosion-resistant material which is not expected to undergo the rapid transformation of plate material to magnetite, which caused the denting problem in the carbon steel tube support plates. Corrosion tests are ongoing in Combustion's laboratories to verify the corrosion phenomena and the resistance of Type 405 stainless steel to that phenomena.

b. The annular gap sees a high velocity flow-through situation which will keep the gap continually flushed. The tube support plates contained large flow holes in addition to the annular gaps, causing washing of the gaps to be minimal or nonexistent. The differing flow arrangements between the original Palisades Plant steam generator tube support plates and the replacement steam generator flow distribution baffle are illustrated in Figure 2.2-3.

2.2.1.3 Blowdown Capability

The potential blowdown capabilities for the replacement steam generators complement the hydraulics associated with the flow distribution baffle and enhance solids control within the operating steam generator. With the incorporation of a flow distribution baffle, recirculating fluid flows exist at velocities sufficiently low to allow the dropout of solid particles only in the center open region of the tube bundle or very near to this region.

In this region, free of heat transfer tubes, blowdown ducts that take suction in a circular pattern adjacent to the innermost tubes are provided. Figure 2.2-4 shows the schematic arrangement of the blowdown duct and its relationship to the tube bundle. At the end of each circumferential section of the blowdown duct, a transport duct (with no blowdown openings) carries the blowdown fluid across the divider lane discharging through intersecting holes drilled in the tubesheet to a 6-inch Schedule 80 blowdown nozzle. See Section 3.1 for a description of the connecting blowdown system. The internal blowdown ducts and tubesheet blowdown connections for the replacement units have been sized to accommodate future higher blowdown capabilities than those available on the original steam generators.

2.2.2 DESIGN FEATURES TO IMPROVE MAINTENANCE AND INSPECTION

2.2.2.1 Handholes

The replacement steam generators will include four 6-inch handhole openings on the lower and intermediate shells to facilitate inspections. The lower two handholes will be positioned just above the tubesheet and have provisions for viewing the top surface of the flow distribution baffle through the tube bundle shroud.

The upper handholes are located just above the eggcrate in the tube lane and are adjacent to the bend region of the tube bundle. These handholes will also incorporate the provision for viewing through the tube bundle shroud (see Figures 2.2-1 and 2.2-10).

2.2.2.2 Inspection Ports

Two 2-inch inspection ports will be added to the replacement units just above the tubesheet secondary face to provide accessibility to the tubesheet surface and to allow use of an inspection device such as a boroscope to observe tubes on either side of an opening between two particular tube rows.

2.2.2.3 View Ports

In addition to the access openings described above, the replacement units will also contain a small number of tube holes through the tubesheet for visual inspection vertically through the tube bundle. These extra tube holes, plugged during normal operation, could allow a boroscope application and could provide broader inspection coverage within the tube bundle.

2.2.2.4 Primary Head Drains

To facilitate draining of the steam generator primary head before maintenance or inspection activities in this area, the replacement units include a drain nozzle (see Figure 2.2-11) on both the inlet and outlet plenums of the primary head. See Section 3.4 for a description of the connecting drain system.

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TABLE 2.1-1

STEAM GENERATOR COMPARISON DATA[1]

	Original Steam Generators	Replacement Steam Generators
A. Primary Side		
1. Thermal power, MWt	2450	2450
2. Design pressure, psi	2500	2500
3. Design temperature, °F	650	650
4. Cold leg temperature, °F	547.8	547.8
5. Hot leg temperature, °F	598.5	598.5
6. Coolant flow, 10^6 lb/hr	62.25	62.25
7. Calculated pressure drop, psid	30.5	29.5
8. Normal operating pressure, psi	2100	2100
B. Secondary Side		
1. Design pressure, psi	1000	1000
2. Design temperature, °F	550	550
3. Flow rate, 10^6 lb/hr	5.281	5.281
4. Steam outlet pressure, psi	770	770
5. Feedwater temperature, °F	429.1	429.1
C. Dimensions		
1. Evaporator outside diameter, in	164	164
2. Steam drum outside diameter, in	239-3/4	239-3/4
3. Overall length, in	709.78	740.00
4. Tubing outside diameter, in	0.750	0.750
5. Tubing wall thickness, in	.048	.042
D. Hydrostatic Pressure		
1. Primary, psia	3125	3125
2. Secondary, psia	1250	1250
E. Weights and Volumes		
1. Complete vessel dry, lb	924,596	937,381
2. Vessel C. G. dry, in	345.32	343.5
3. Secondary fluid 0% power, lb	209,180	208,965
4. Secondary fluid 100% power, lb	129,164	138,254

Note:
[1] Values are per steam generator, except Item A.1.

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TABLE 2.1-2

REPLACEMENT STEAM GENERATOR DATA [1]

		Safety Analysis	Design
A.	**Primary Side**		
1.	Thermal power, MWt	2530	2650
2.	Design pressure, psi	2500	2500
3.	Design temperature, °F	650	650
4.	Cold leg temperature, °F	542.5	547.8
5.	Hot leg temperature, °F	595.4	598.5
6.	Coolant flow, 10^6 lb/hr	62.5	70.0
7.	Calculated pressure drop, psid	29.6	36.1
9.	Normal operating pressure, psi	2100	2250
B.	**Secondary Side**		
1.	Design pressure, psi	1000	1000
2.	Design temperature, °F	550	550
3.	Flowrate, 10^6 lb/hr	5.491	5.786
4.	Steam outlet pressure, psi	770	770
5.	Feedwater temperature, °F	435	438
C.	**Weights and Volumes**		
1.	Complete vessel dry, lb	937,381	937,381
2.	Vessel C.G. dry, in	343.5	343.5
3.	Secondary fluid 0% power lb	208,965	208,965
4.	Secondary fluid 100% power, lb	136,863	134,441

NOTE:
(1) Valves are per steam generator, except Item A.1.

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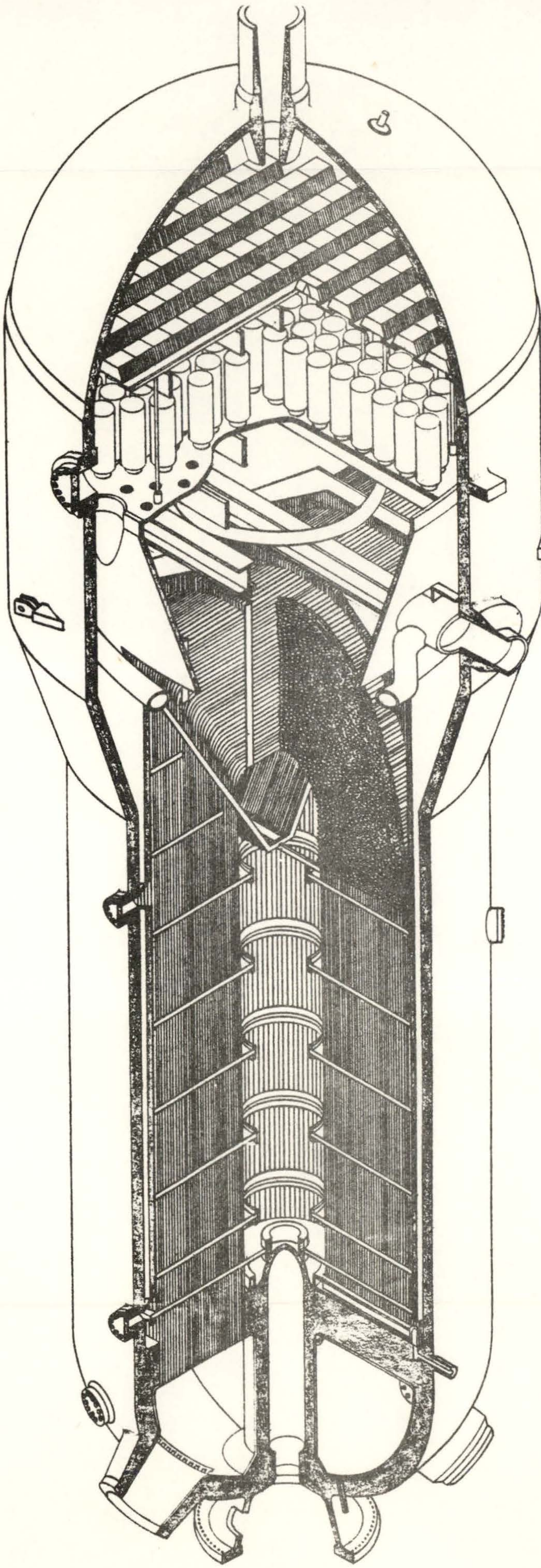
TABLE 2.2-1

STEAM GENERATOR MATERIALS

	Original Steam Generators	Replacement Steam Generators
Upper, intermediate, and cone shells	SA-302, Grade B alloy steel	SA-533, Grade A, Class I alloy steel
Lower shell	SA-516, Grade 70 carbon steel	SA-533, Grade A, Class I alloy steel
Tubesheet forging	SA-508, Class II alloy steel	SA-508, Class III alloy steel
Tube support plates	SA-36 carbon steel	--
Eggcrate tube supports	A-570, Grade D/ A-303-64, Grade D carbon steel	A-176, Type 409 stainless steel
Primary head	SA-302, Grade B alloy steel	SA-533, Grade B, Class I alloy steel
Primary head clad	Stainless steel	Stainless steel
Tubesheet clad	Inconel	Inconel
Heat transfer tubing	SB-163 Inconel	SB-163 Inconel
Flow distribution baffle	--	SA-240, Type 405 stainless steel
Secondary head	SA-516, Grade 70/ SA-302, Grade B carbon steel/ alloy steel	SA-516, Grade 70 carbon steel
Nozzles/primary stay	SA-508, Class II alloy steel	SA-508, Class III alloy steel



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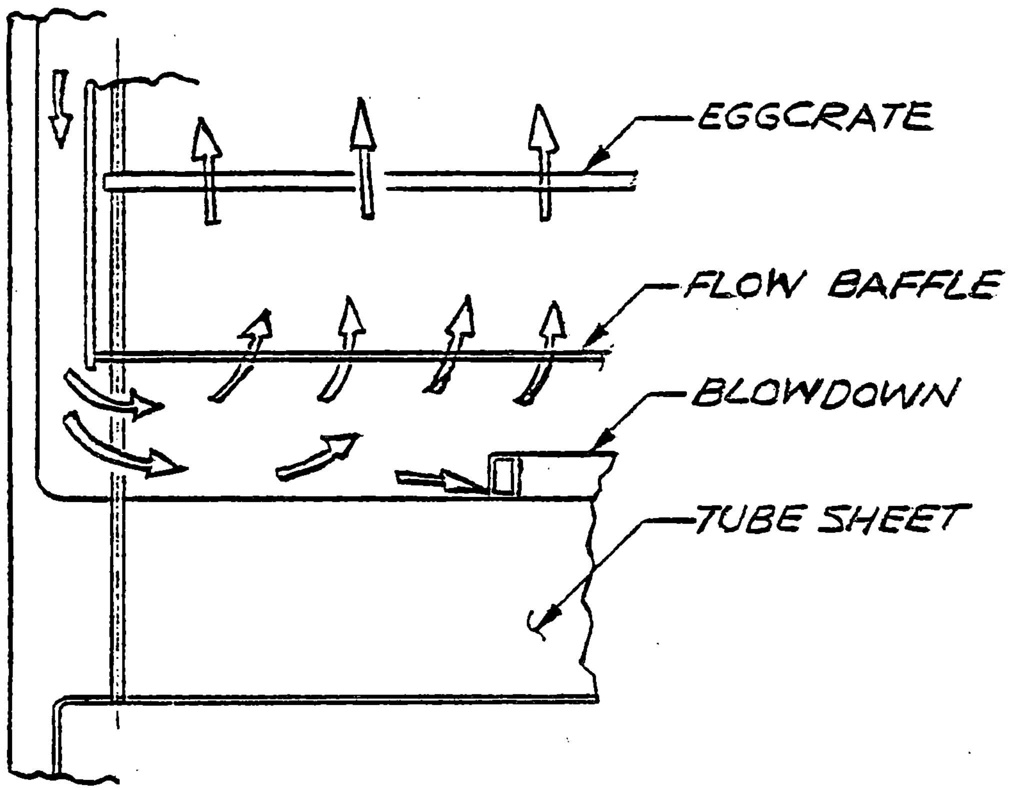
REPLACEMENT STEAM GENERATORS

Figure 2.2-1



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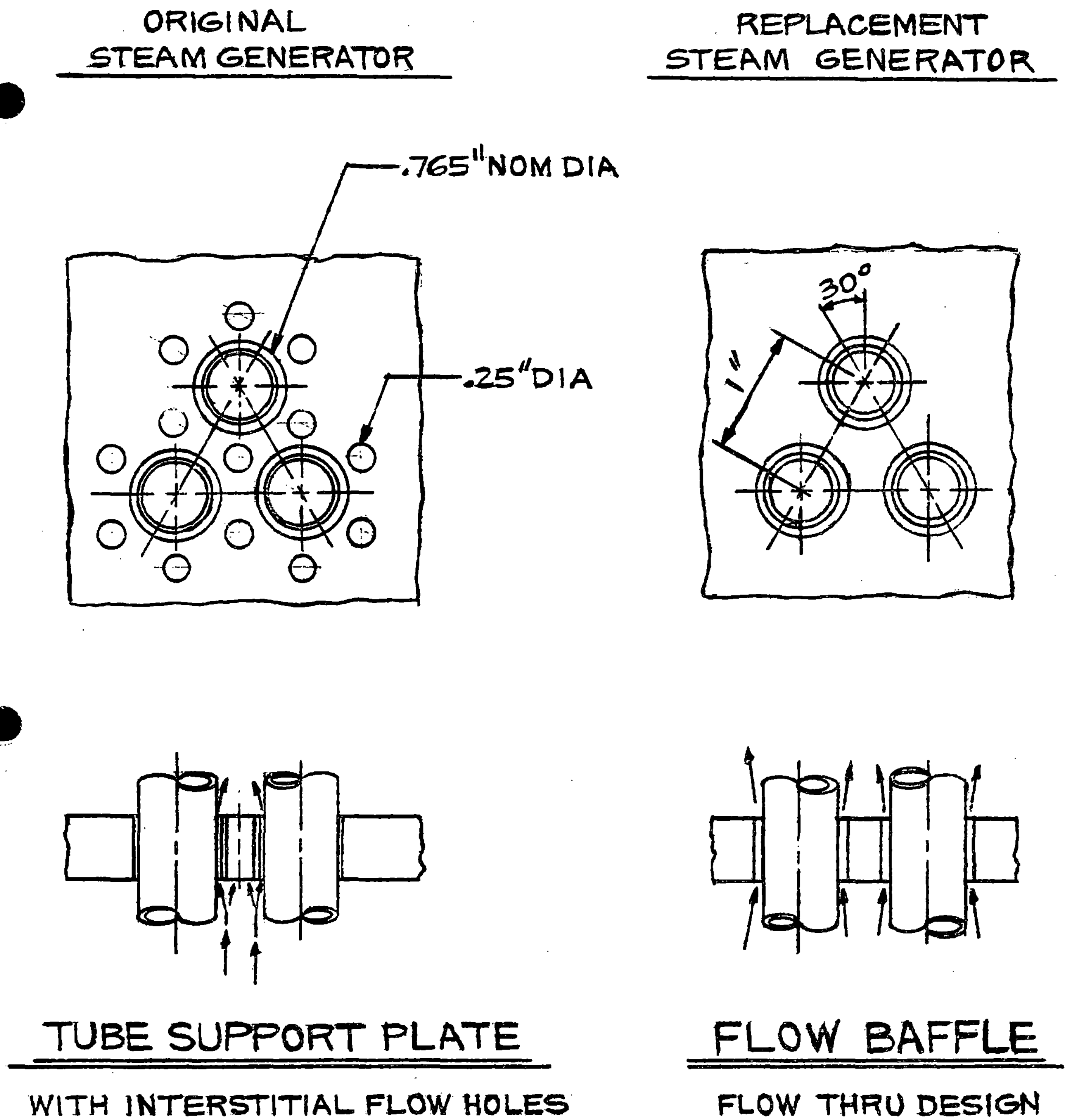
FLOW DISTRIBUTION BAFFLE

Figure 2.2-2



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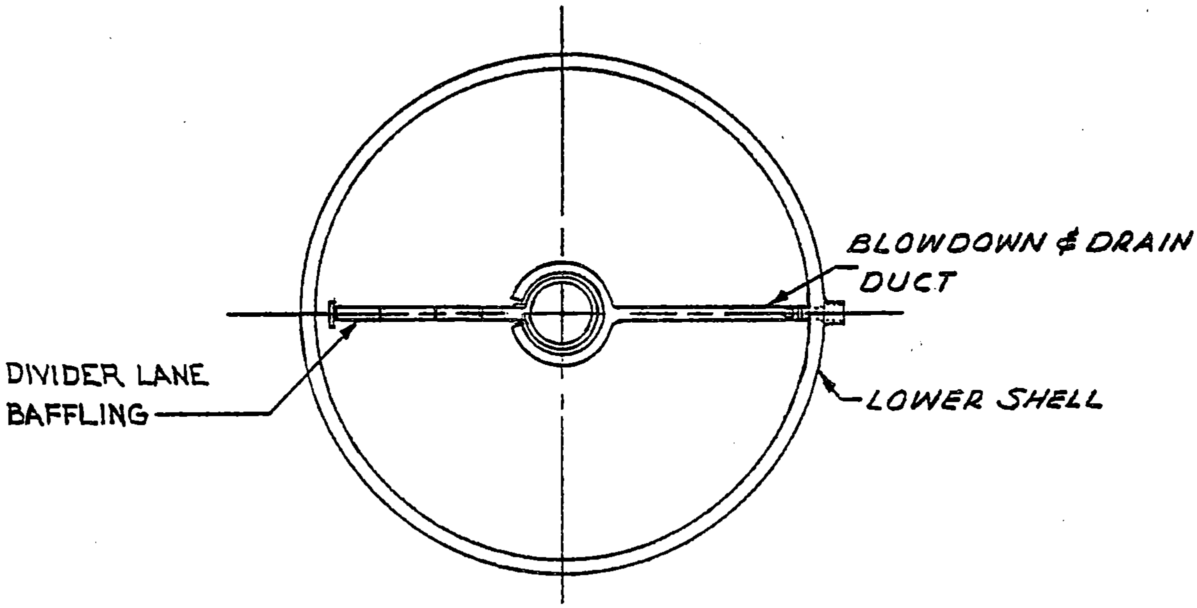
TUBE SUPPORT PLATE
AND FLOW BAFFLE

Figure 2.2-3



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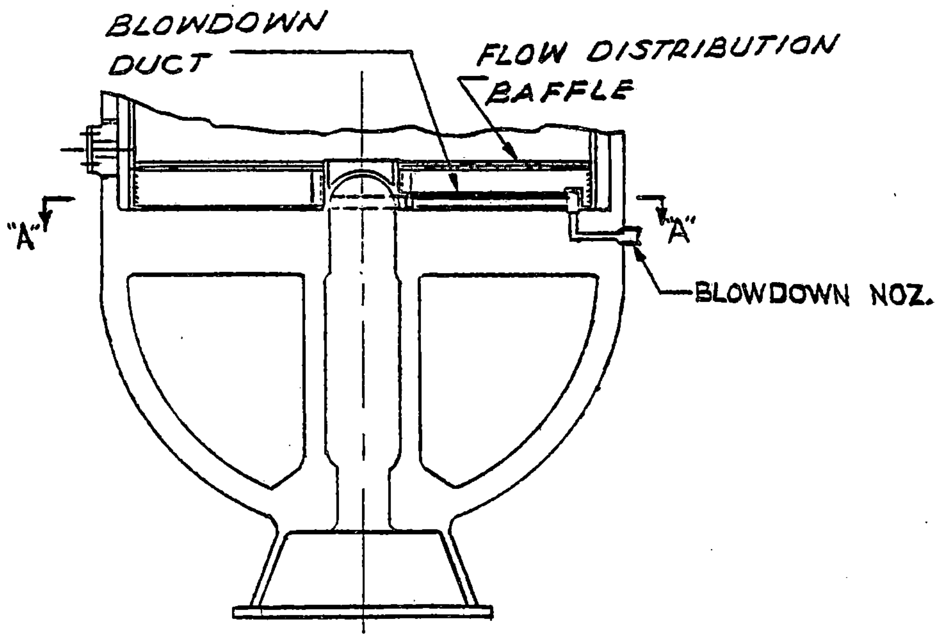

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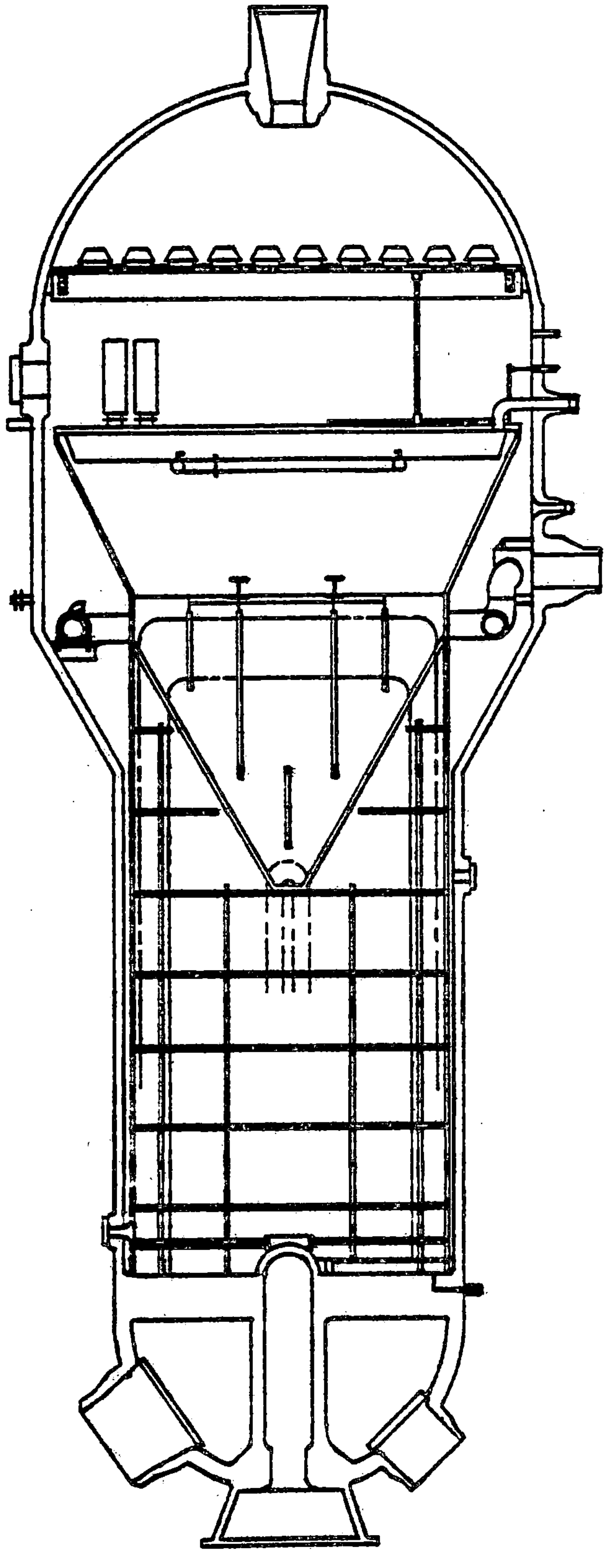
BOTTOM BLOWDOWN
DUCT ASSEMBLY

Figure 2.2-4



PALISADES PLANT STEAM GENERATOR REPAIR REPORT
STEAM GENERATOR - FLOW RESTRICTOR NOZZLE Figure 2.2-10

3.5 WIDE RANGE LEVEL INDICATION

A differential pressure type level transmitter will be added to each new steam generator to provide steam generator wide range level indication of about 44 feet. The top head of the new steam generators will have a 1-inch nozzle at el 671', which will be used for the low-pressure sensing line connection. The high-pressure sensing line will be connected to pressure taps at el 627' (see Figure 3.5-1). With this addition, an operator can determine the water level in the secondary side of each steam generator during wet layup (or similar operations) beyond the range measurable with the present level indicators (about 15 feet).

The new level indicating system is functionally independent, both electrically and mechanically, of any safety-related systems. The sensing lines will be in accordance with ASME Code Section III, Class 2 and seismic Category I classifications. The transmitter will be located in a low radiation zone. The transmitter output will electrically connect to a new indicator in the main control room and will not be used to automatically initiate or terminate any action.

6.0 SAFETY EVALUATIONS

6.1 FSAR EVALUATIONS

6.1.1 INTRODUCTION

To be provided later.

6.1.2 NON-LOCA ACCIDENTS

To be provided later.

6.1.2.1 Excessive Feedwater

To be provided later.

6.1.2.2 Excessive Load Increase

To be provided later.

6.1.2.3 Loss of Load

To be provided later.

6.1.2.4 Loss of Feedwater Flow

To be provided later.

6.1.2.5 Steam Line Break

To be provided later

6.1.2.6 Steam Generator Tube Rupture

To be provided later

6.1.3 LOSS-OF-COOLANT ACCIDENT EVALUATION

To be provided later.

6.1.4 CONTAINMENT PRESSURE ANALYSIS

To be provided later.

6.1.5 FSAR EVALUATION CONCLUSIONS

To be provided later.