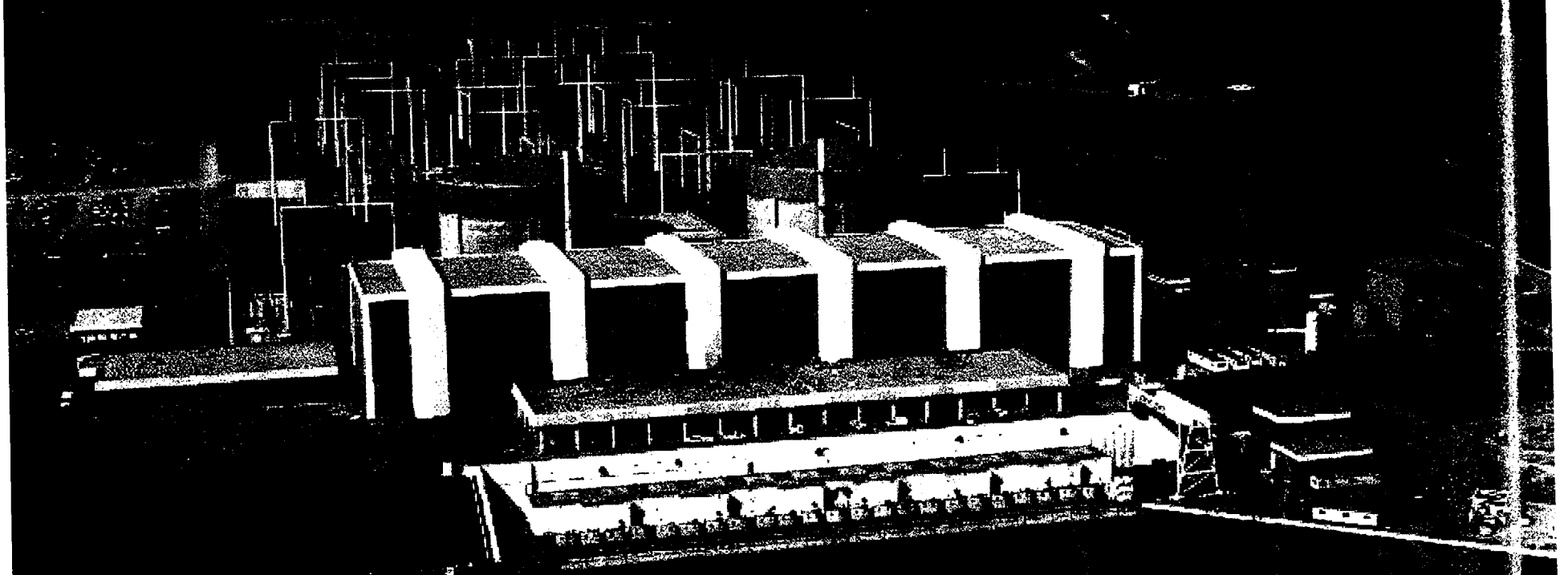
# Calvert Cliffs Nuclear Power Plant

# Steam Generator Replacement



## NRC Presentation

## April 25, 2001

BABCOCK & WILCOX M a McDermott company

Constellation Nuclear

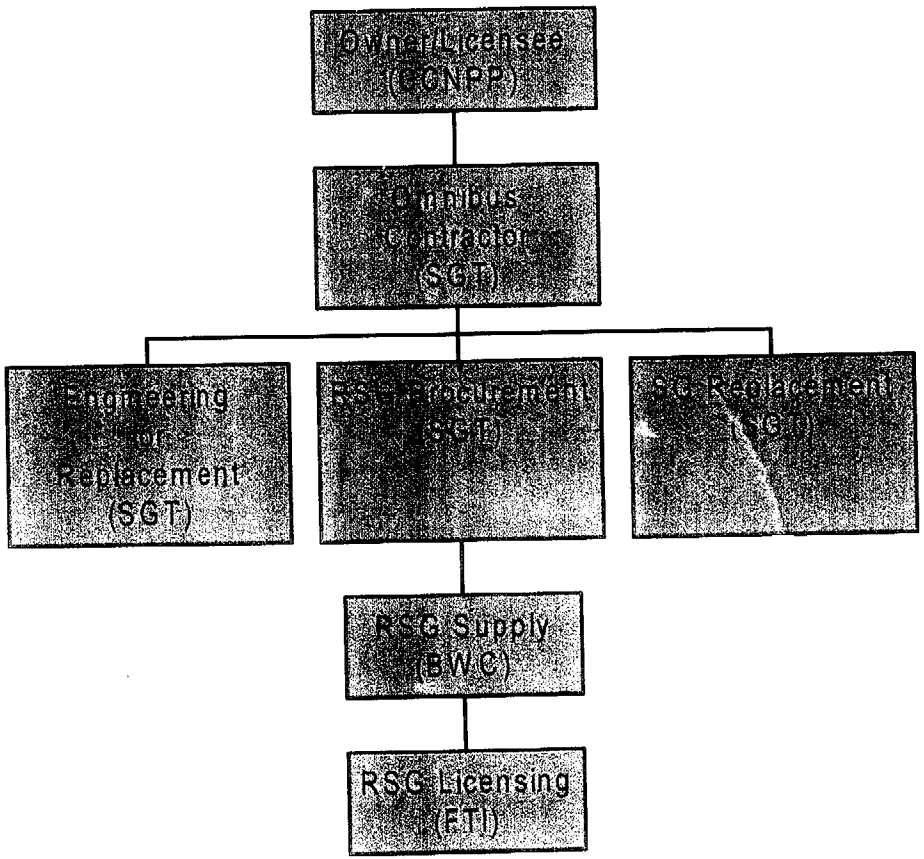
The Steam Generating Team SGT Ltd.

ATTACHMENT 1

# Reasons for Replacement

- **Minimize:**
  - **Extended Outages, Costly Inspections**
  - **Mid-cycle Outages**
  - **Expensive Repairs and Analysis**
  - **Tube Leak Threat**
  - **Reduced Power Operation**

# Functional Relationships



# Project Milestone Schedule

- June 1998 - Contract for Replacement
- September 2001 - Unit I SGs Delivered
- February 2002 - Unit I Replacement Outage
- July 2002 - Unit II SGs Delivered
- March 2003 - Unit II Replacement Outage

# Steam Generator Procurement Schedule

| | NG1 | NG2 | NG3 | NG4 |
|---|---|---|---|---|
| Receipt of Tubesheet | 13-Oct-98 | 14-Oct-98 | 22-Jan-99 | 22-Jan-99 |
| Complete Gundrilling | 28-May-99 | 21-Sep-99 | 1-Dec-99 | 15-Feb-00 |
| Receipt of Primary Head | 6-Aug-99 | 27-Aug-99 | 12-Oct-99 | 4-Nov-99 |
| Complete Welding of Divider Plate to Primary Head | 2-Sep-99 | 15-Nov-99 | 18-Jan-00 | 3-Apr-00 |
| Complete Sec Shell Welds (except small nozzles) | 16-May-00 | 21-Jun-00 | 21-Nov-00 | 3-Apr-01 |
| Complete PWHT of Lower Section | 29-Jun-00 | 29-Jul-00 | 10-Jan-01 | 24-May-01 |
| Receipt of Tubes | 14-Jul-00 | 15-Sep-00 | 22-Dec-00 | 22-Jan-01 |
| Complete Installation of Tubes | 9-Jan-01 | 30-Jan-01 | 4-Jun-01 | 30-Oct-01 |
| Start Final Expansion of Tubes | 19-Apr-01 | 28-May-01 | 12-Oct-01 | 1-Mar-02 |
| Hydrotest | 31-May-01 | 10-Aug-01 | 12-Dec-02 | 1-May-02 |
| Ex-Cambridge | 17-Aug-01 | 31-Aug-01 | 21-Jun-02 | 5-Jul-02 |
| Arrive at Site | 17-Sep-01 | 17-Sep-01 | 21-Jul-02 | 21-Jul-02 |

# Replacement SG Design Features

## ❖ Primary

- ➢ Self Draining Channel Head
- ➢ 18" Primary Manways
- ➢ Chrome Plated Diaphragm Plates
- ➢ Electropolished Channel Head
- ➢ I690 Tubesheet Cladding
- ➢ I690TT Tubes with > 15:1 S/N Ratio
- ➢ I690 Divider Plate

# Replacement SG Design Features

- **Secondary**
  - **Additional Handholes**
  - **Improved Blowdown Capability**
  - **Forged Secondary Shell**
  - **Stainless Steel Tube Supports**
  - **Tube Support Inspection Ports**

# Replacement SG Design Features

## ❖ Secondary

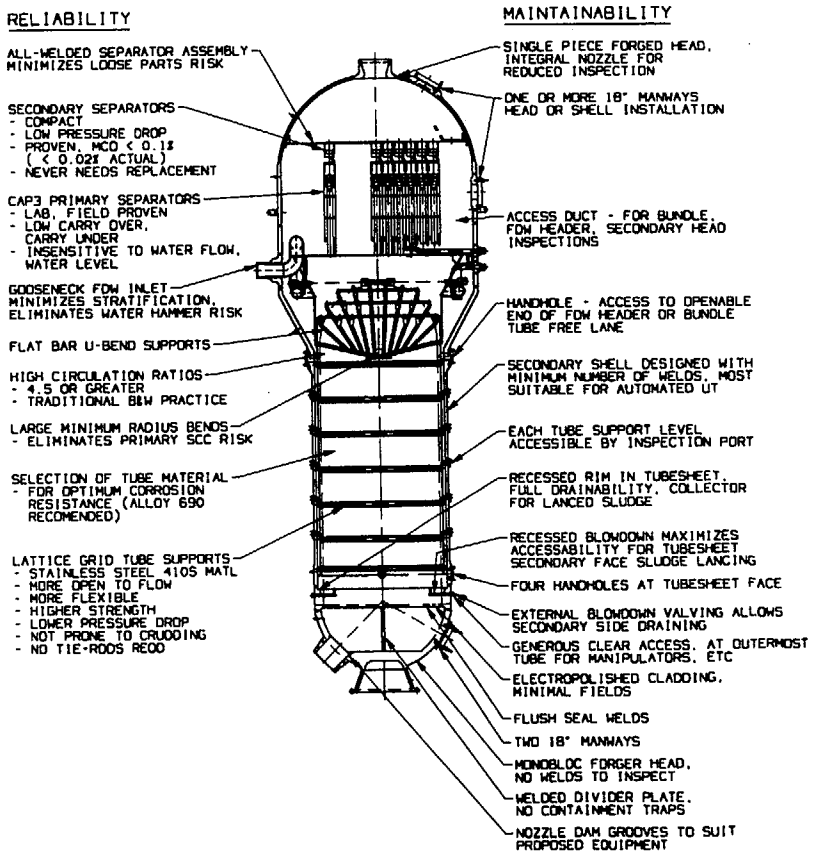
- ➢ Gooseneck Feedwater Nozzle Design
- ➢ Extended Thermal Sleeve
- ➢ Recirculation Nozzle
- ➢ Improved Moisture Separation Equipment
- ➢ Added Integral Main Steam Flow Restrictor

Blow down feature.

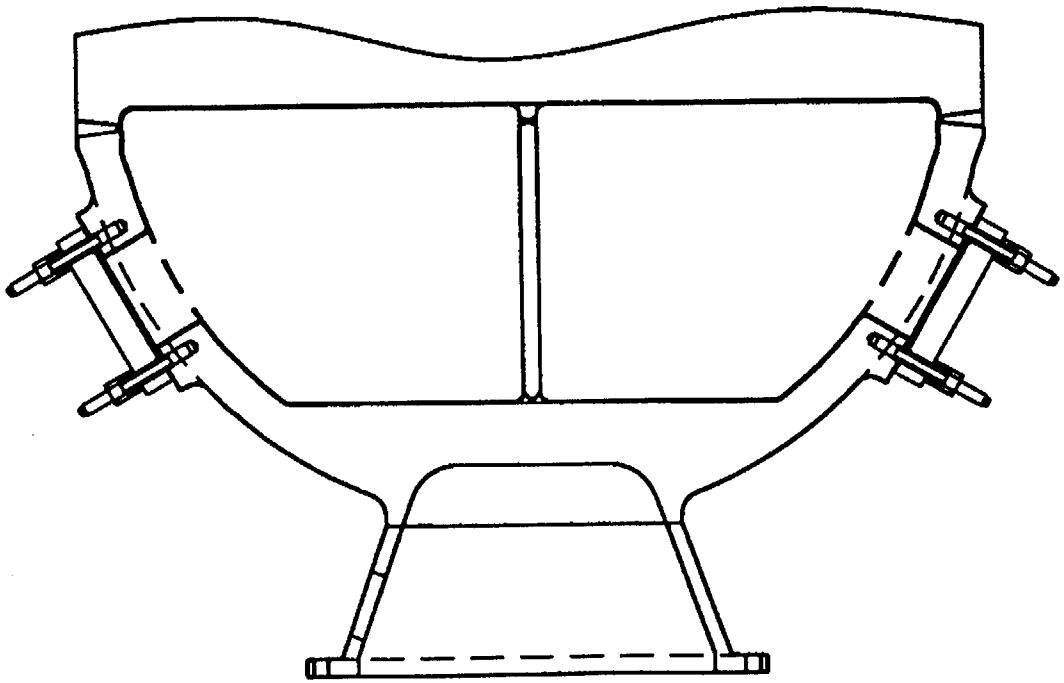
600 — 610
- Manual

410 SS U-bend bar
Lattice,
Non-Volume gap exists,

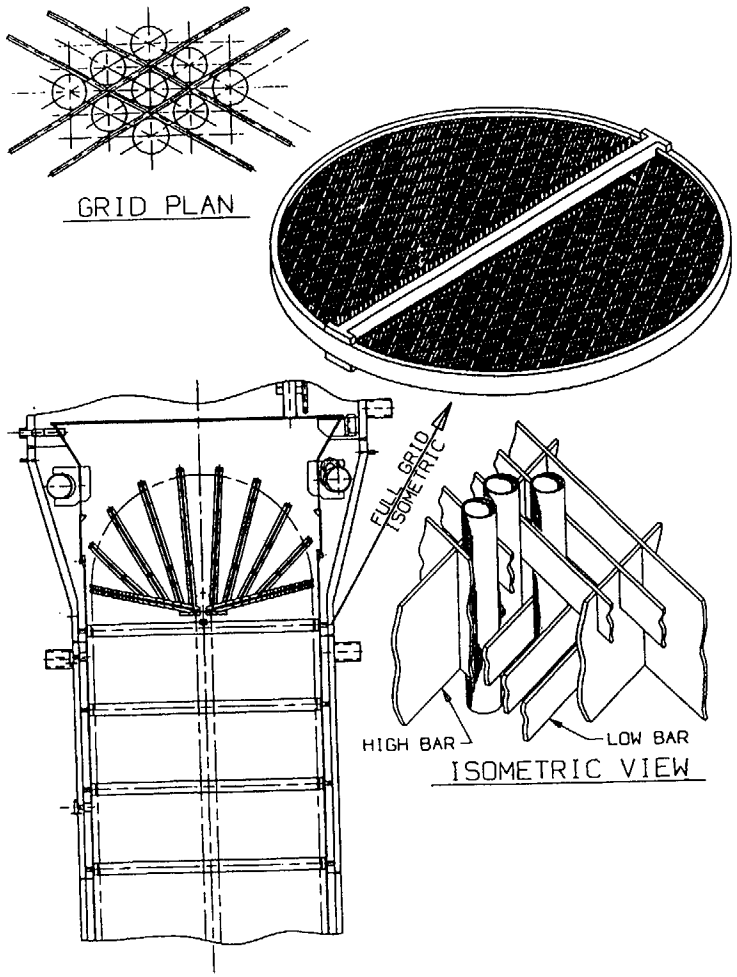
# Reliability & Maintainability Features



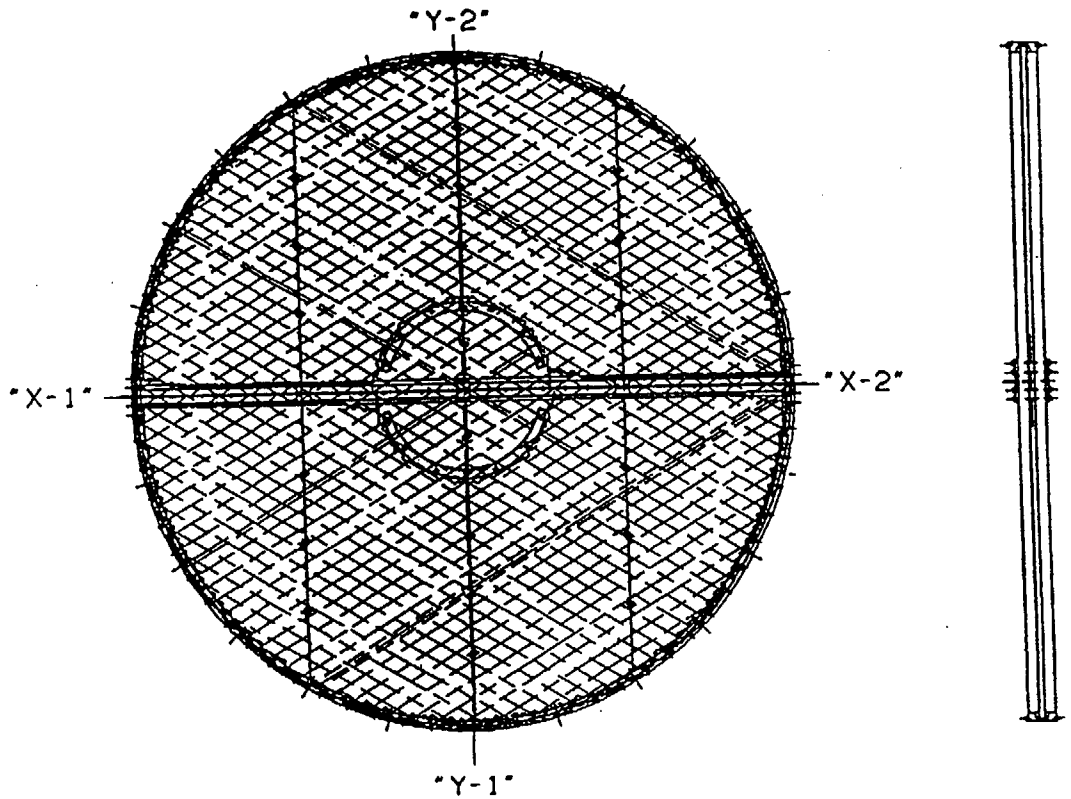
# Primary Head Design



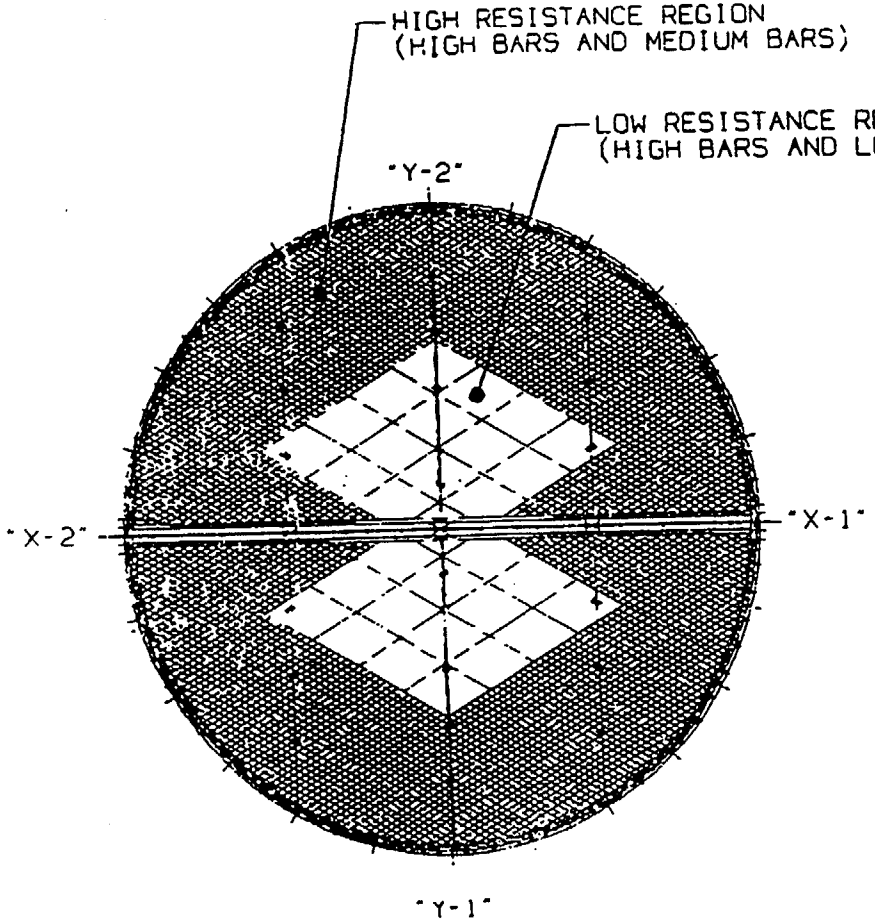
# Lattice Grid Tube Supports



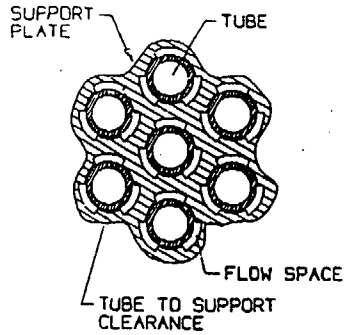
# Lattice Grid Assembly

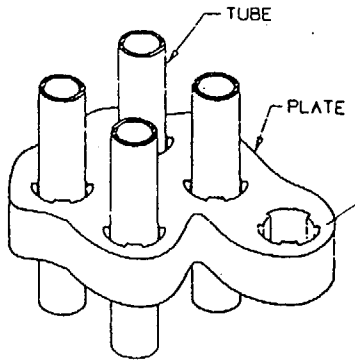


# Differential Resistance Lattice

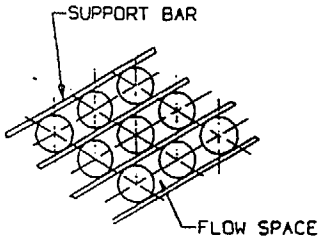


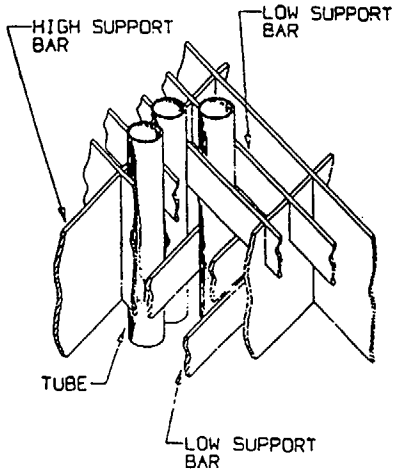
# Lattice Grid Supports Free Flow Space



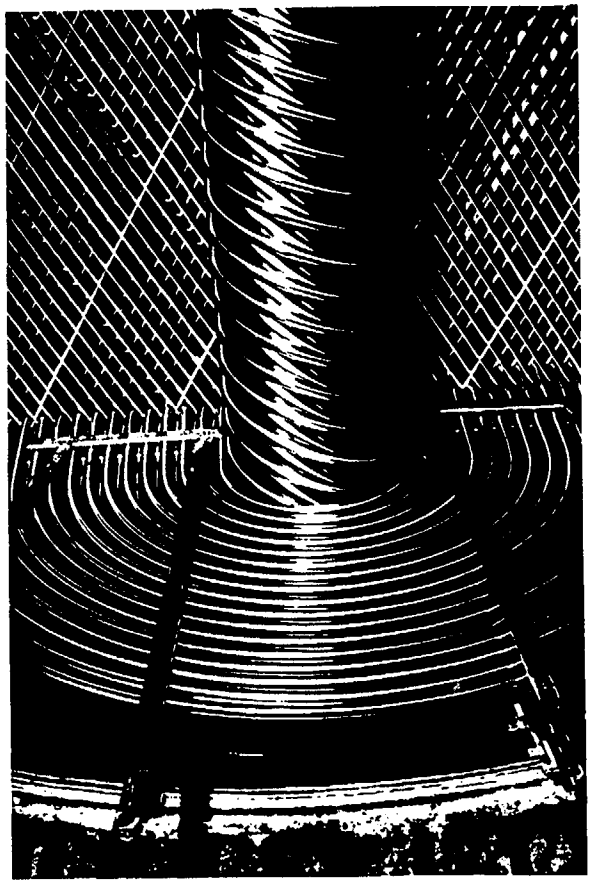

Comparison purpose



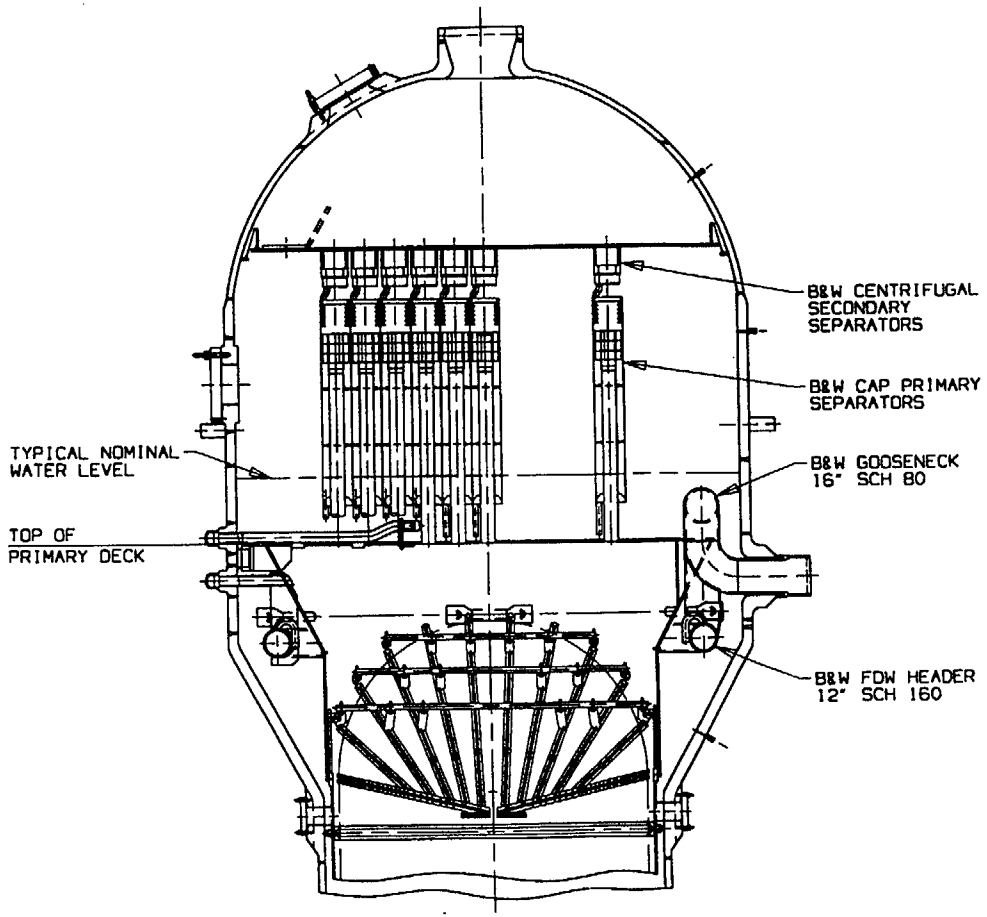




— Lattice design.

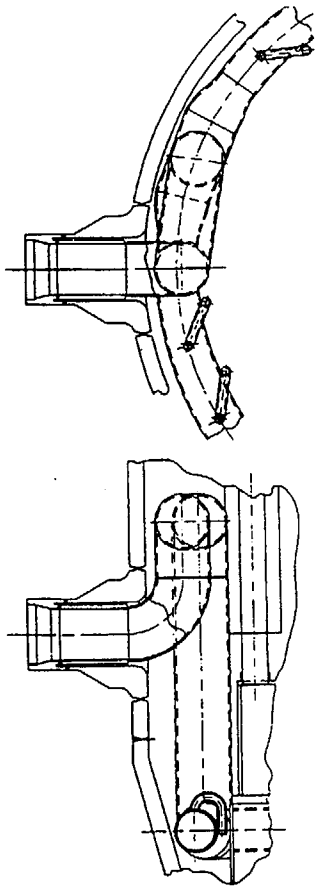
# Type 410S
# Tube Support Material



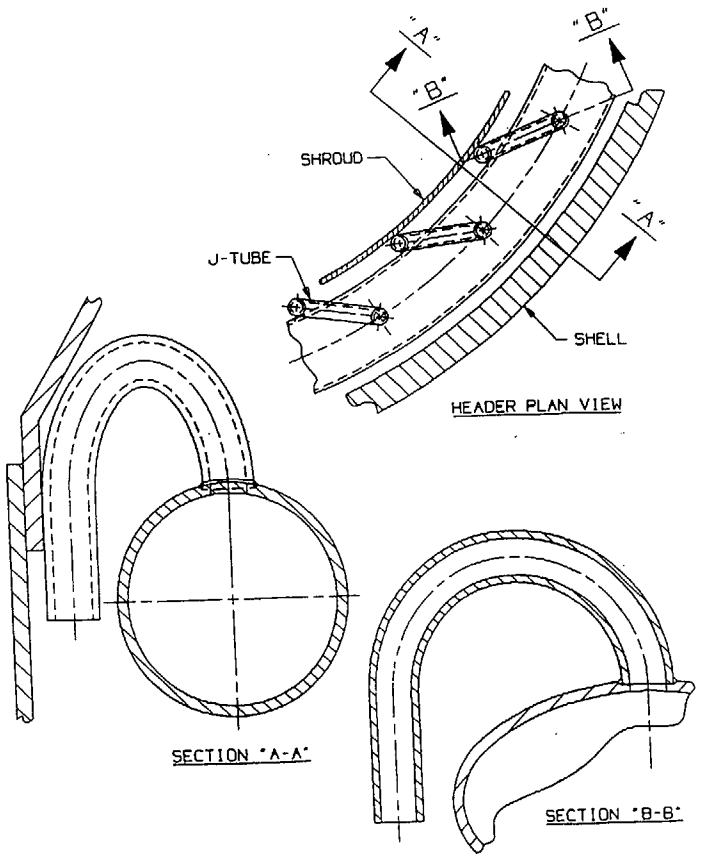
# Steam Drum Arrangement



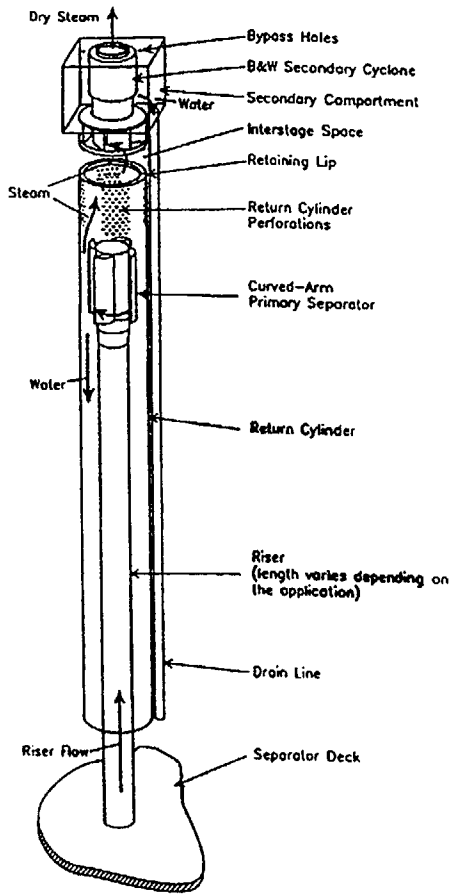
# Feedring Header Distribution Systems



# J-Tube Design



# Primary & Secondary Separators



# Replacement SG Design Features

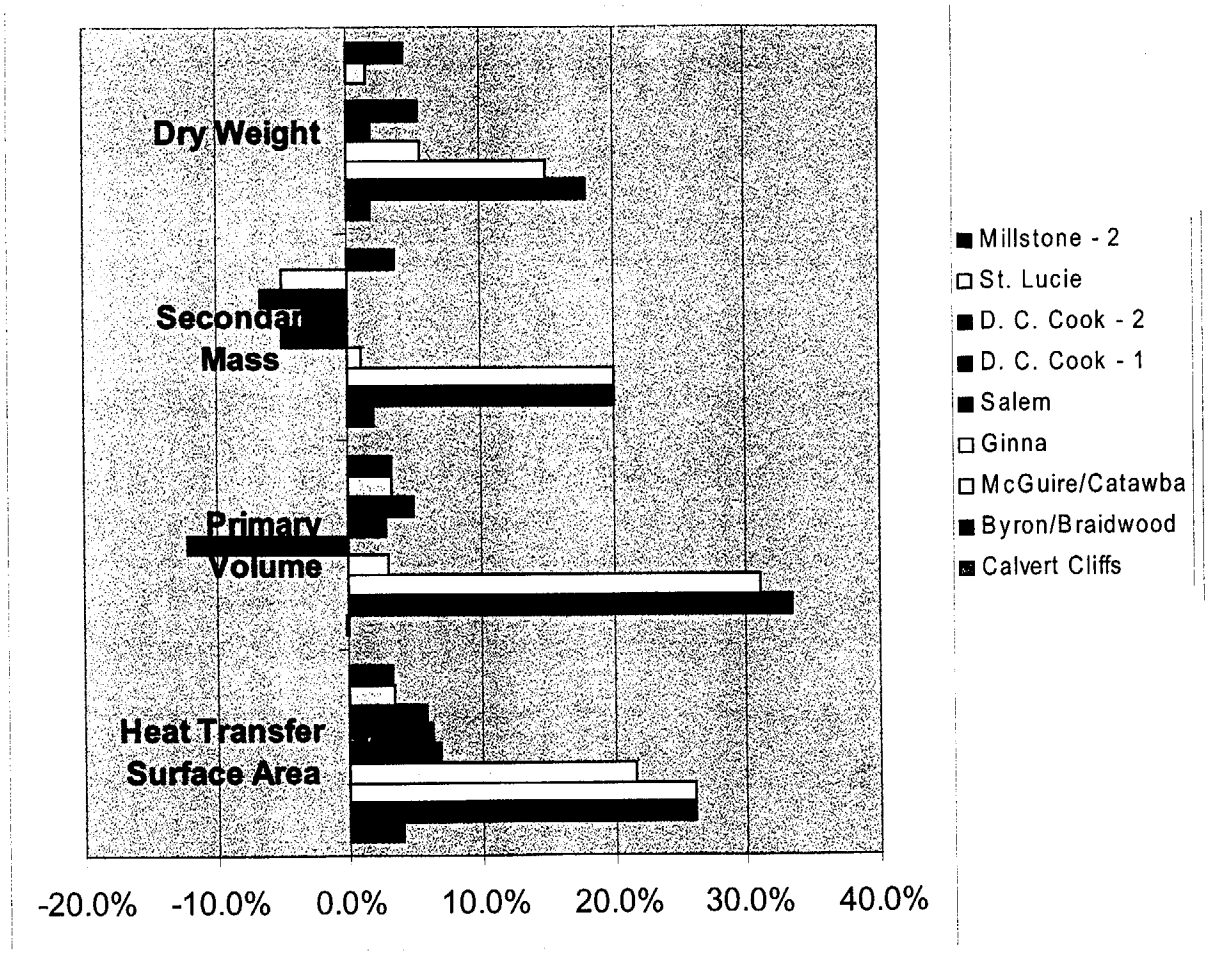
- **Secondary Performance Features**
  - **Lower Void Fraction**
  - **<0.05% Moisture Carryover**
  - **Improved Circulation Ratio**
  - **Improved Water Level Stability**

# System Operating Parameters

## ❖ Will closely match present conditions

| Parameter | Original Design | Replacement Design | % Change |
|---|---|---|---|
| Heat Transfer Area (sq ft) | 90,200 | 92,008 | +2.0% |
| Primary Volume (cu ft) | 1,646 | 1,641 | -0.30% |
| Secondary Inventory @100% (lbm) | 135,986 | 138,525 | +1.9% |
| Moisture Carryover @100% (%) | 0.20 | 0.05 | -75.0% |
| Circualtion Ratio | 4.0 | 4.5 | +12.5% |
| Tube Diameter (in) | 0.75 | 0.75 | - |

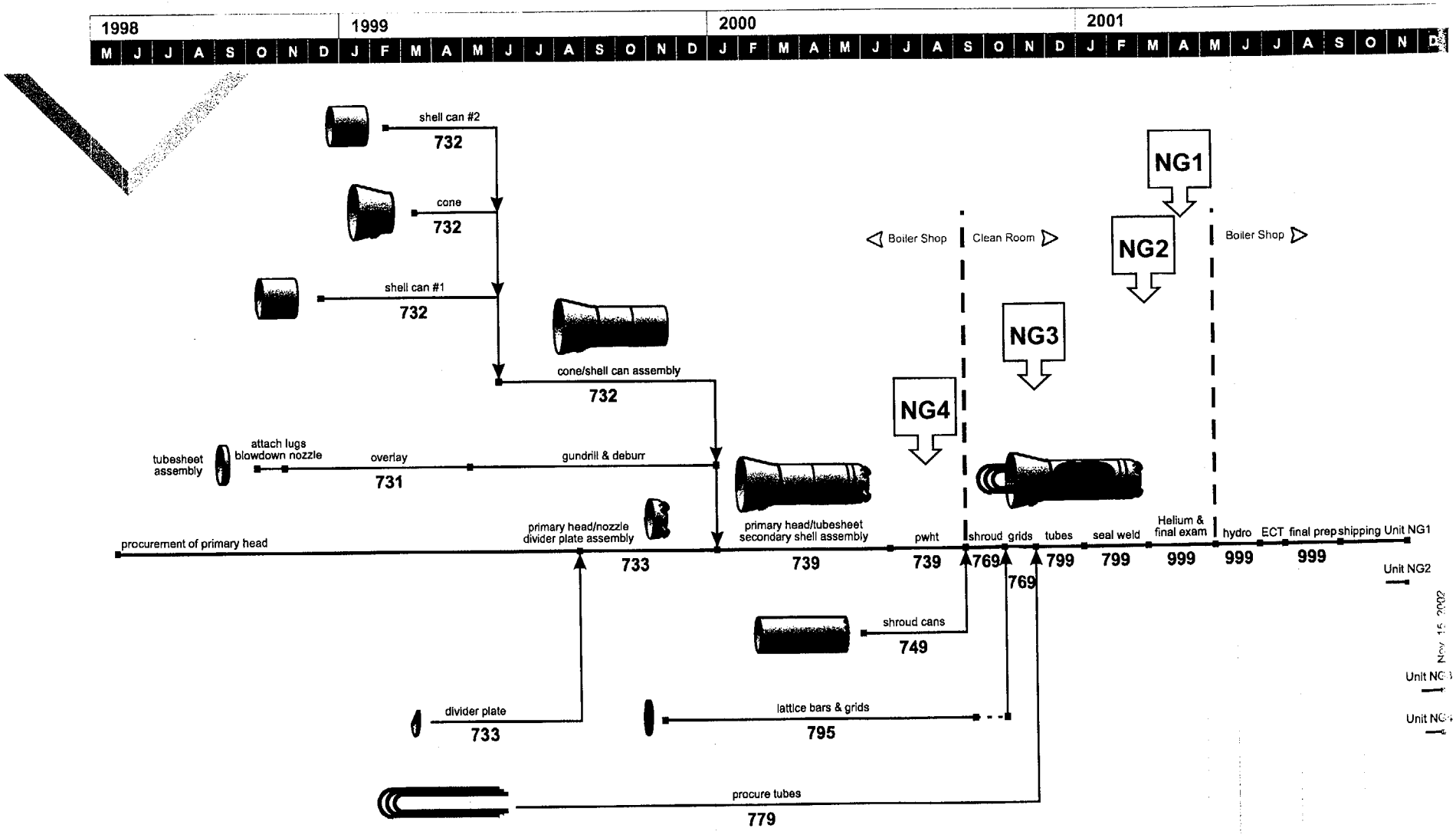
# Comparisons of SGRPs




% Change From Original

# Transient Analyses

- **RSG design minimizes reanalysis**
  - **limit primary volume**
  - **use existing level setpoints**
  - **<1% increase in heat transfer capacity**
  - **equivalent secondary operating pressure**
  - **equivalent secondary volume**
  - **equivalent primary dP**






Babcock & Wilcox, a McDermott company

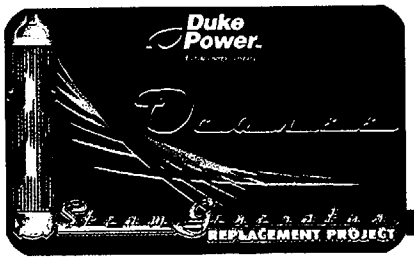
Constellation Nuclear

The Steam Generating Team SGT Ltd.

# Duke Power's
# Project Overview Presentation
# to the
# Nuclear Regulatory Commission

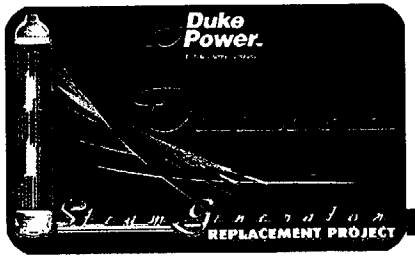
***April 25, 2001***

ATTACHMENT 2

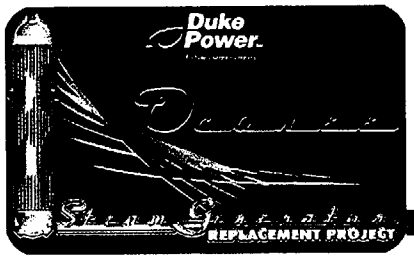



# Agenda

- Project Overview
- Steam Generator Procurement
- Replacement Steam Generator (ROTSG) Description
- Steam Generator Removal & Replacement
- Licensing
- Close



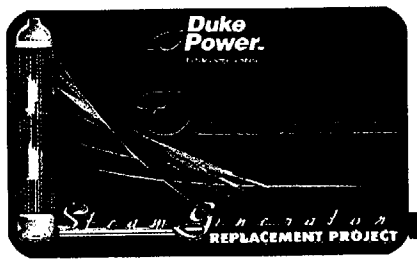

# Project Overview




75 days breaker to breaker

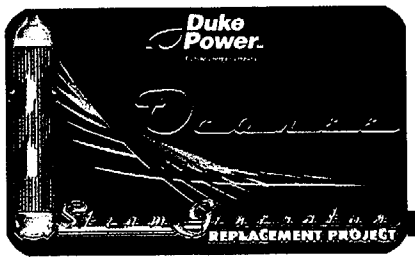
# Meeting Objectives

- Inform the NRC of Duke's Plans to Replace Oconee's Steam Generators
- Present an Overview of the Project (Video)
- Discuss Anticipated Licensing Activities Related to the Project
- Present a Detailed Description of ROTSG Improvements



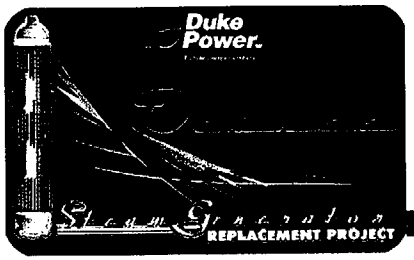

# Background

- Oconee Unit 1 Was First 177 FA Babcock & Wilcox Designed NSSS Placed in Service
- Commercial Operation
  - Unit 1 - 7/15/73
  - Unit 2 - 9/9/74
  - Unit 3 - 12/16/74
- 2 Once Through Steam Generators Per Unit
- Unit 1 OTSGs Have Provided Longest Service of Any Currently Operating Steam Generators in U.S.




# Replacement Evaluation

- Degradation of Tubes
- Current OTSGs Will Not Reach End of Current License
- License Extension Has Been Approved
- Cost Justified With or Without License Extension
- Evaluated New Vs. Existing OTSGs (Midland)
- Plan to Replace OTSGs for Units 1, 2 and 3 in Fall 2003, Spring 2004, and Fall 2004, Respectively

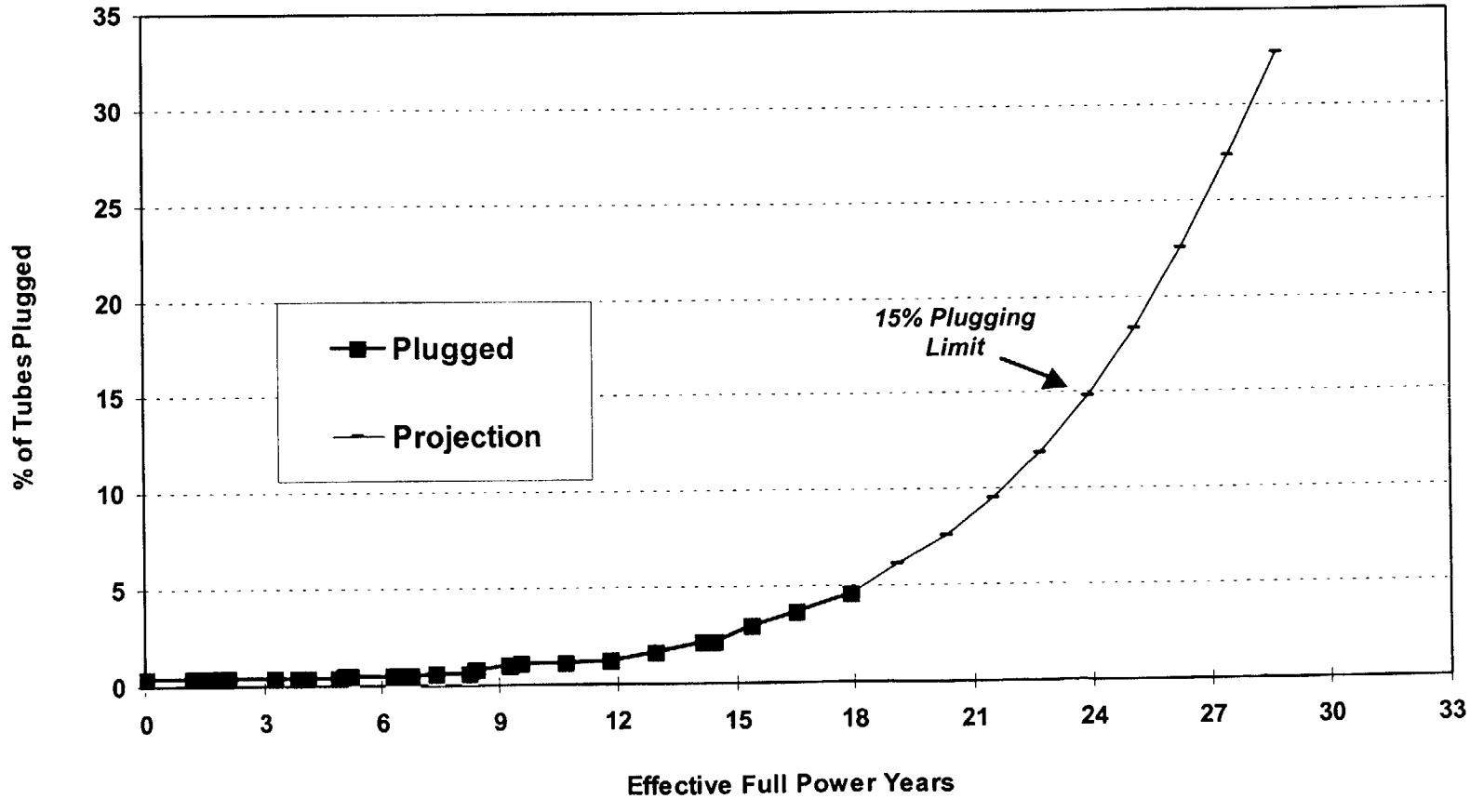



# Total Tubes Repaired

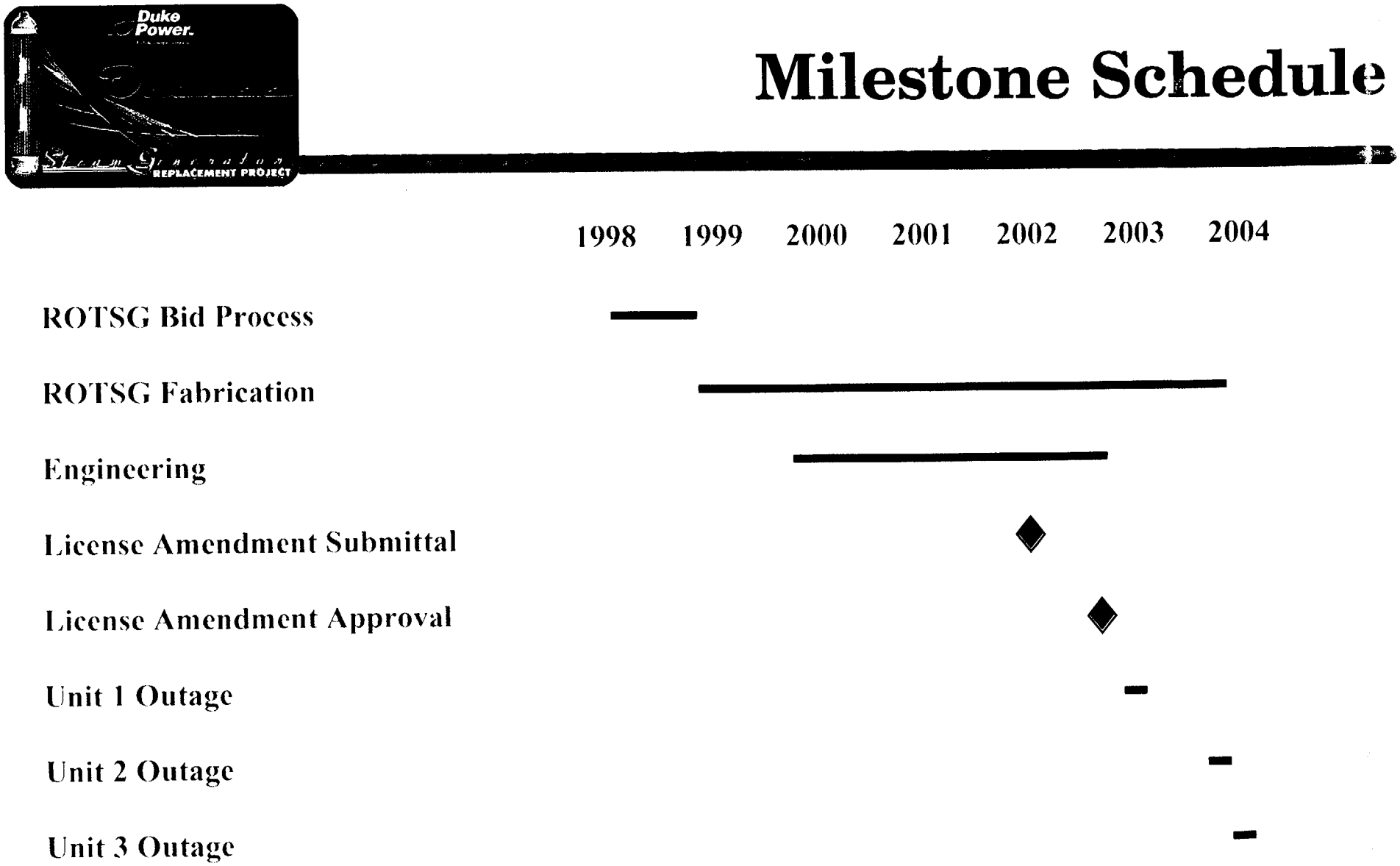
As of 1/4/01

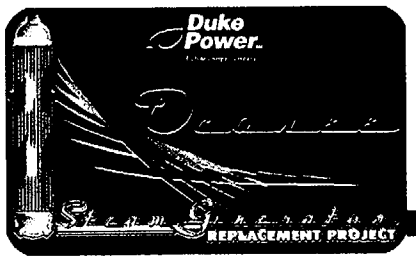
| | | Total Tubes | Plugged | Percent Plugged | Rerolled | Sleeved In-Service |
|---|---|---|---|---|---|---|
| ONS-1 | 1A | 15,531 | 633 | 4.08% | 2,618 | 247 |
| | 1B | 15,531 | 1796 | 11.56% | 2,380 | 180 |
| | ONS-1 | 31,062 | 2429 | 7.82% | 4,795 | 427 |
| ONS-2 | 2A | 15,531 | 677 | 4.36% | 117 | 275 |
| | 2B | 15,531 | 893 | 5.75% | 276 | 252 |
| | ONS-2 | 31,062 | 1,175 | 5.05% | 256 | 533 |
| ONS-3 | 3A | 15,459 | 938 | 6.07% | 126 | 281 |
| | 3B | 15,531 | 686 | 4.42% | 259 | 247 |
| | ONS-3 | 30,990 | 1,386 | 5.2% | 385 | 528 |

# Tube Degradation



# Milestone Schedule





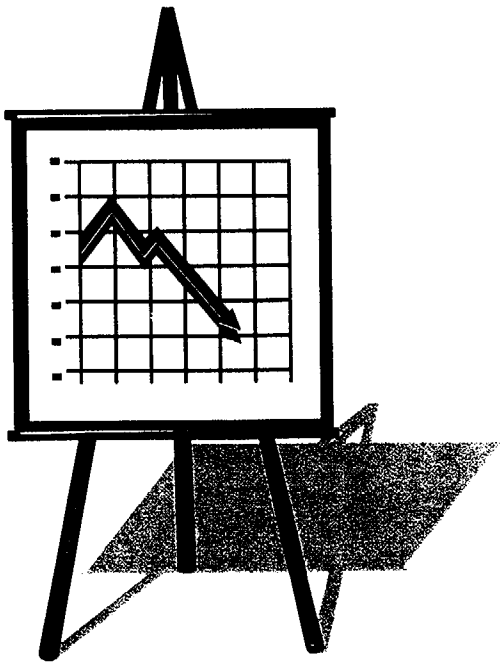

# Key Project Strategies

- Life of Plant Design
- Like-for-Like Replacement
- Design Improvements
- Experienced Project Team

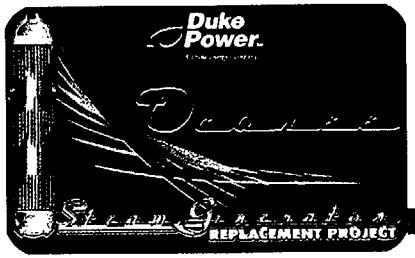
# Project Goals

- **Outage Duration** **<75 Days**
- **Outage Dose** **<147 Rem Per Unit**

Now have to consider head replacement.



# Project Organization



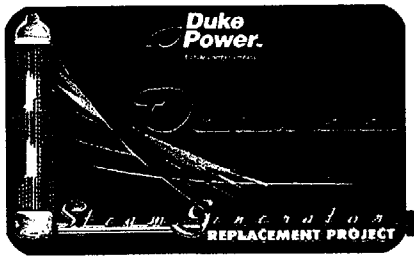

**Project Director**

**Duke Project Team**

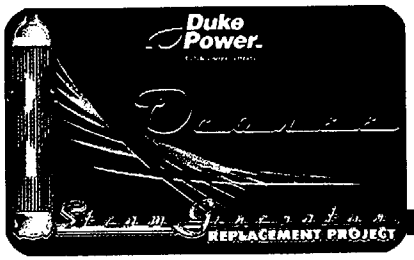
- Project Administration
- Project Oversight
  - Engineering
  - Radiation protection
  - Quality Assurance
  - Licensing
  - Purchasing / Contracts
  - Site Interface

**Installation Contractor (SGT)**

- Implementation
  - Engineering
  - Construction
  - Radiation Protection
  - Quality Assurance
  - Licensing
  - Safety
  - Training

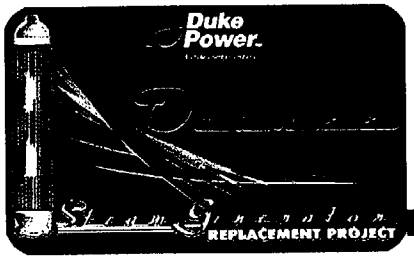



# Steam Generator Procurement and Replacement Steam Generator Description



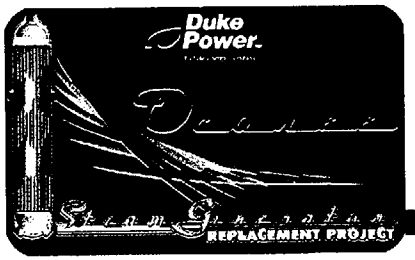

# Replacement OTSG Procurement

- Contract Awarded to B&W Canada (BWC) on March 31, 1999 for 6 Replacement Steam Generators
- Delivery
  - Unit 1 - 6/1/03
  - Unit 2 - 1/1/04
  - Unit 3 - 7/1/04
- Major Subsuppliers
  - Tubes - Sumitomo
  - Heavy Forgings - Japan Steel Works
  - Tube Support Plates - Creusot Loire




# Replacement OTSG Design Improvements

- Based on Duke and B&W Operating Experience
- Materials / Technology Improvements

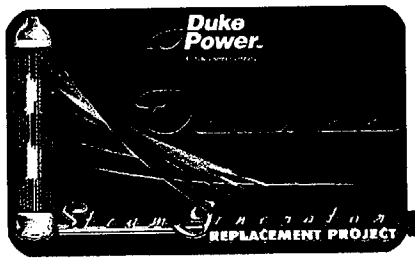



# Replacement OTSG Design Improvements

22" tube sheet 2" thinner

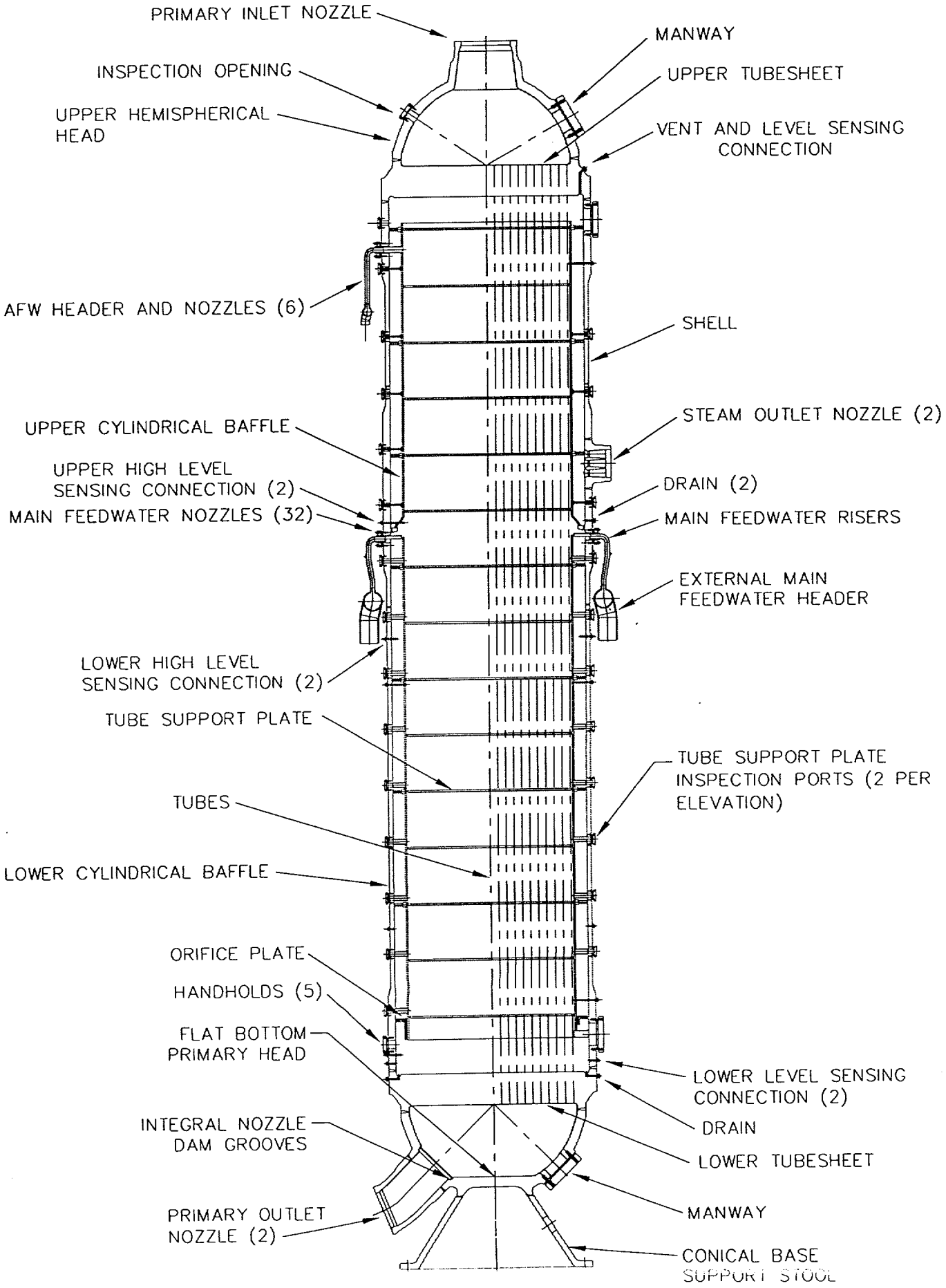
## ◆ Specific Improvements

- Erosion/corrosion resistant materials incorporated
- High strength steel forgings for shell, tubesheets and primary heads
- Alloy 690TT tubes
- Inconel main feedwater nozzles
- SS broached support plates
- Open tube lane tubed
- Hydraulically expanded tubes
- Steam outlet flow restrictor added — different from C.C.
- Feedwater / Auxiliary Feedwater connections seal welded
- Increased secondary side design pressure
- Conical support pedestal
- Predetermined and controlled application of tube pre-stress
- Flat bottom, self-draining lower primary head

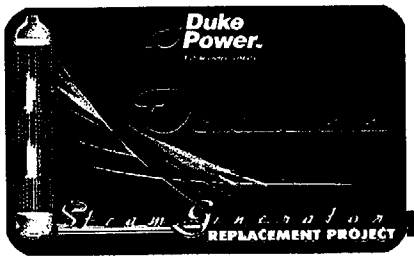



# OTSG/ROTSG Comparison
## (Preliminary)

| | OTSG | ROTSG |
|---|---|---|
| Thermal Output (MWt) | 1292 | 1292 |
| Steam Outlet Pressure (psia) | 925 | 925 |
| Primary Flow (lbm/hr x E6) | 65.66 | 65.65 |
| Thot/Tcold/Tavg (nominal)(deg F) | 604/554/579 | 604/554/579 |
| Number of Tubes | 15,531 | 15,625 |
| Surface Area (sqft) | 132,966 | 134,546 |
| Thermal Conductivity (BTU/hr-ft2-degF @ 550 deg F) | 10.83 | 9.85 |
| Superheat (deg F)(BOL) | 59.7 | 62.7 |
| Operating Weight | 637 | 551 |
| Primary Side Volume (cuft) | 2030 | 2007 |

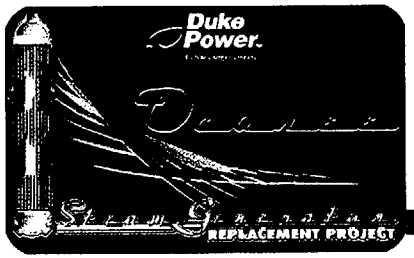



ROTSG LONGITUDINAL SECTION



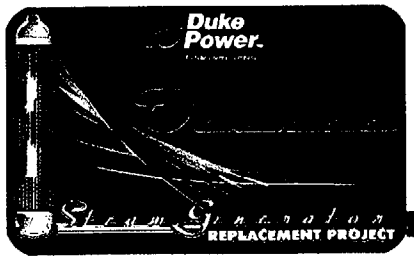

# Engineering

- **Design Requirement Supported by Commercial Penalties**
  - No adverse change to unit operation or transient response caused by ROTSGs
- **No Significant Piping Modifications**
- **Existing Reflective Metal Insulation will be Replaced with New**



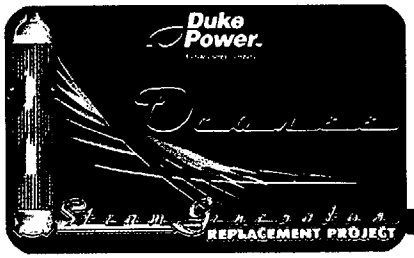

# Reconstitution of NSSS Structural Design Basis

- Reanalysis by Framatome ANP
- Inputs Will Reflect Current Licensing Basis
- LBB Will Be Used as Input to Structural Design




# Steam Generator Disposal

- Evaluated Off-site Disposal Vs. On-site Storage
- Current Plan Is For Original Steam Generators To Be Stored on Site
- Following Construction, Storage Facility Will Be Used As Prep-facility For Replacement Steam Generators




# Steam Generator Removal and Replacement

# Installation Contractor

- **Steam Generating Team (SGT)**
  - Joint Partnership of Washington Group and Duke Engineering & Services
  - Washington Group, Duke, SGT Steam Generator Replacement Project Experience
    - Point Beach Units 1 & 2
    - DC Cook Unit 2
    - Catawba Unit 1
    - McGuire Units 1 & 2
    - St. Lucie Unit 1
    - Indian Point Unit 2
    - Calvert Cliffs Units 1 & 2
    - Prairie Island Unit 1
    - Callaway

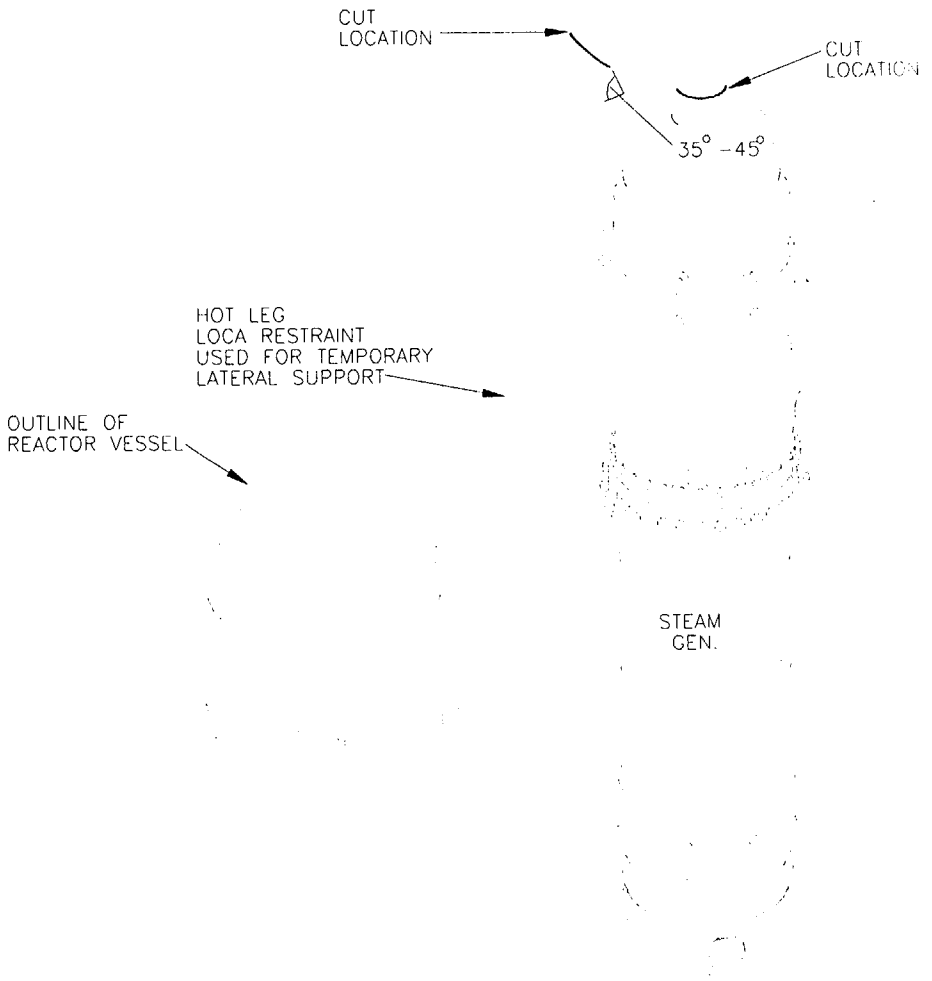
The Steam Generating Team

SGT Ltd.

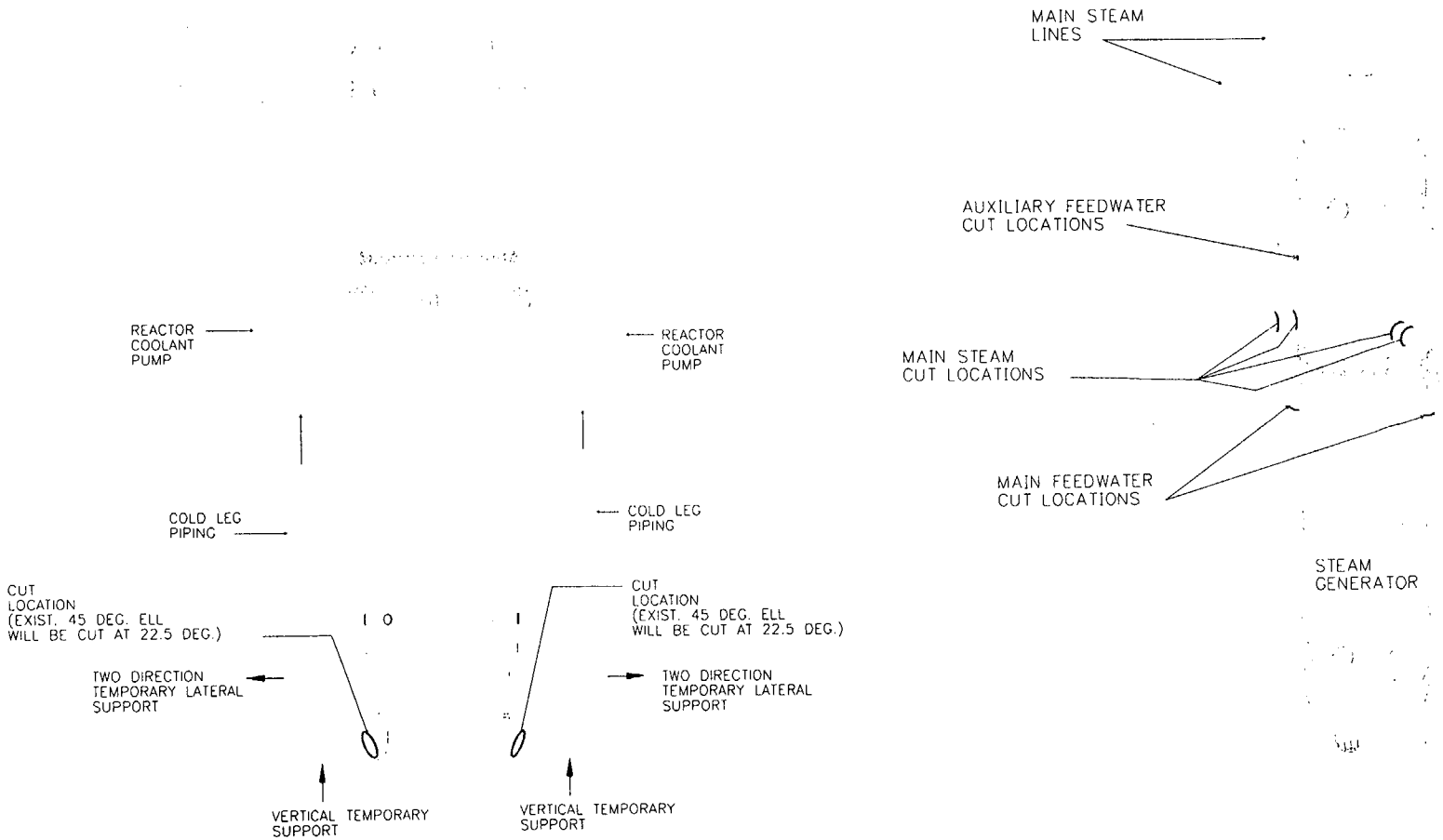
*A Washington Group International, Inc. / Duke Engineering & Services, Inc. Company*

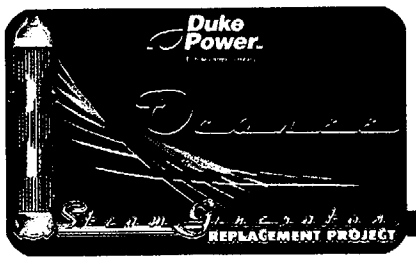
# Steam Generator Removal/Replacement

- **Steam Generator Cut Locations Optimized to Facilitate Steam Generator Removal and Installation of Replacement Steam Generators**



# Cut Location Figure

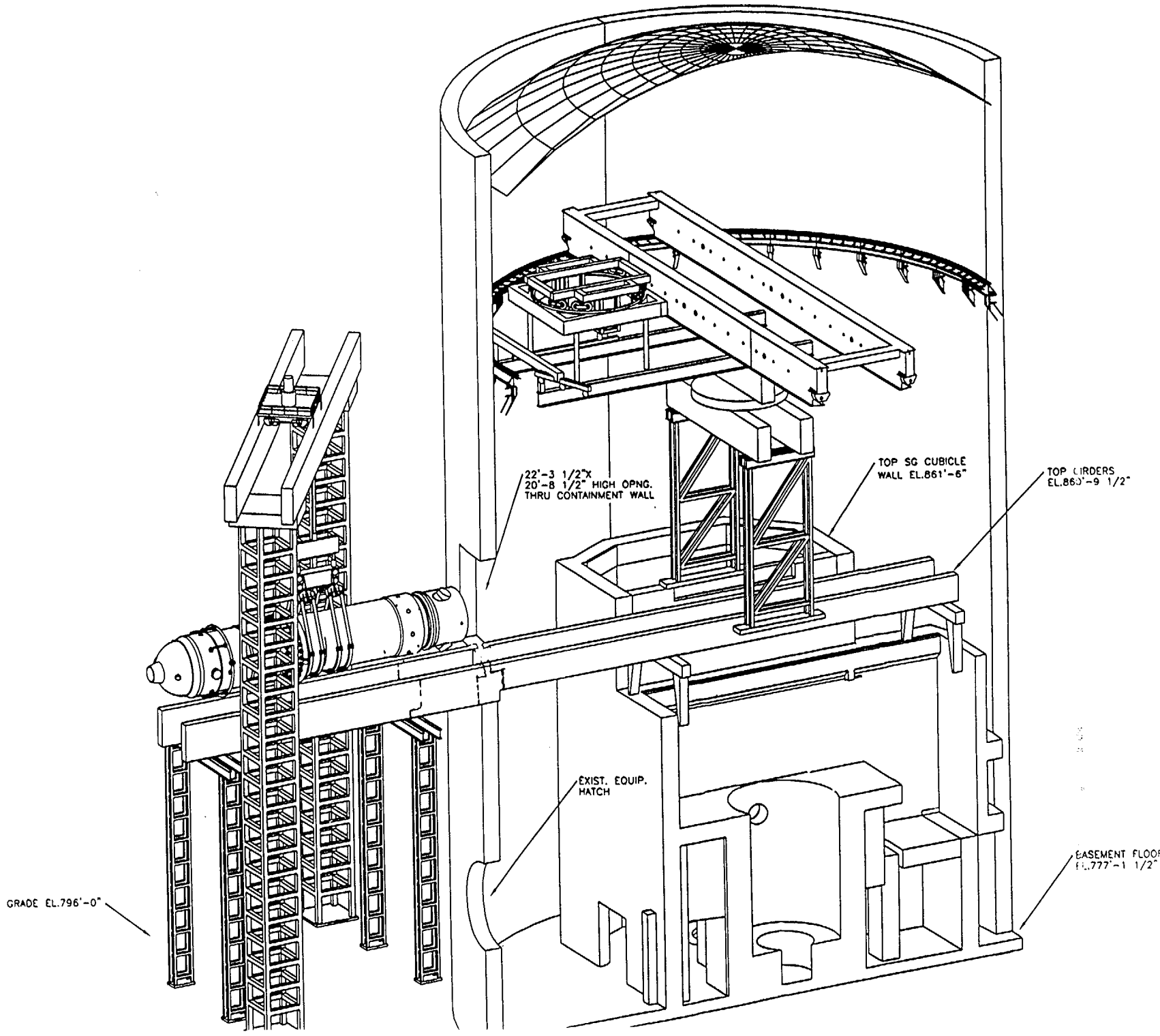


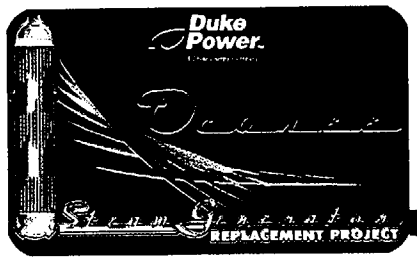



# Removal of Steam Generators From Containment

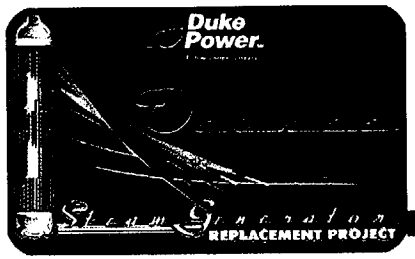
## Two Options Considered:

- **Existing Equipment Hatch**
  - Requires extensive removal/replacement of structures inside Containment and equipment including a portion of the fuel transfer canal and a section of CCW piping outside Containment
- **Containment Wall Opening**
  - Involves cutting 20 X 25 foot opening in Containment
  - Successfully completed at other plants
  - Less critical path time


22'-3 1/2"X
20'-8 1/2" HIGH OPNG.
THRU CONTAINMENT WALL
TOP SG CUBICLE
WALL EL.861'-6"
TOP GIRDERS
EL.863'-9 1/2"
EXIST. EQUIP.
HATCH
GRADE EL.796'-0"
BASEMENT FLOOR
EL.777'-1 1/2"




# Licensing




# Licensing Approach

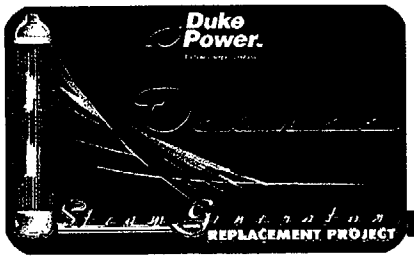
- Steam Generators Are a "Like-for-Like" Replacement
- Minimal Impact on Containment (Ch 6) or Accident (Ch 15) Analysis
- Majority of Replacement Activities Accomplished Under 50.59 and 50.65
- License Amendment Needed to "Clean Up" Steam Generator Surveillance Tech Spec and Revise Topical Report References
  - Delete references to sleeving, re-rolled tubes and open tube lane

# Other Licensing Actions

- **Other NRC Approvals / License Amendments**
  - ASME Code Cases 2142-1, 2143-2, and N-20-4 (Complete)
  - Loop Analysis Methodology (In Progress)
  - Duke Topical Report Revisions

- **Large Break LOCA Thermal Transient**
  - Pursuing resolution for ROTSGs through B&W Owners Group
  - Preliminary analysis has demonstrated that the tubes will not fail

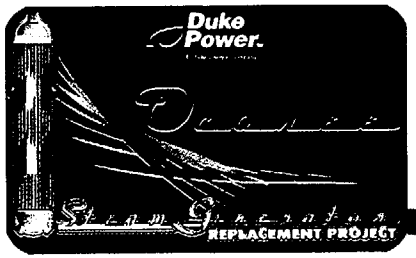
Chapter 6.




# Modifications/Temporary Alterations

- Steam Generator Supports
- Steam Generator Structural Interference
- RCS Piping Supports#
- Mainsteam piping
- Feedwater Piping
- Emergency Feedwater Piping
- Scaffolding/Shielding
- Nitrogen Injection System#
- Temporary Services
- Steam Generator Replacement
- Blowdown#
- Auxiliary Cranes
- Chemical Addition#
- Vent Line#
- Insulation
- RCS Instrumentation Lines#
- Secondary Instrumentation Lines
- Facilities
- Original Steam Generator Retirement Facility#
- Containment Opening
- Rigging & Handling
- Steam Generator Transport
- Reactor Cavity Decking
- Prior Outage Supports#
- Temporary Electrical Power
- Nitrogen Injection#

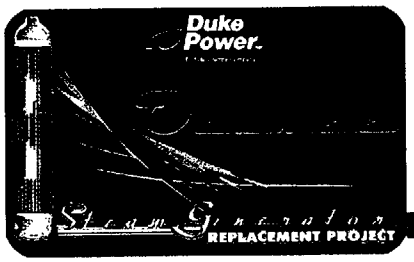
# - Modifications




# Licensing Schedule

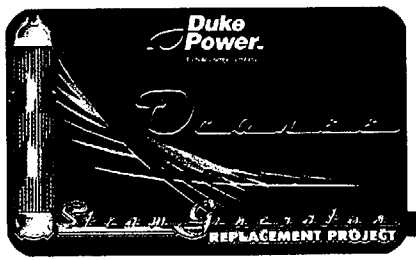
- **Code Case Approval Requests**
  - 2142-1 and 2143-1 Approved 9/10/99
  - N-20-4 Approved 12/22/99
- **License Amendment**
  - Anticipated submittal - August 2002
  - Requested approval - August 2003 (first replacement outage starts Sept 2003)
  - NRC/NEI proposal to revise steam generator surveillance Technical Specifications would eliminate need for SGRP specific license amendment except for Topical Report references

NEI 97-06

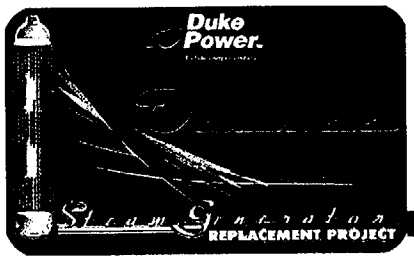



# NRC Interface

- Project Status Updates to NRR and/or Region on Periodic Basis
- Tour of BWC Shop (Cambridge, Ontario) During Steam Generator Fabrication
- Weekly Meetings With Region / Resident Inspectors During Replacement Outage




# Closing




# Summary

- Experienced Project Team (Duke/SGT/BWC)

Duke Energy℠

The Steam Generating Team
SGT Ltd.
A Washington Group International, Inc. /
Duke Engineering & Services, Inc. Company

BABCOCK & WILCOX

- Goal - Continued Safe and Economical Operation of Oconee