SOUTH TEXAS PROJECT

ELECTRIC GENERATING STATION

SPECIFICATION FOR

REPLACEMENT STEAM GENERATORS

HOUSTON LIGHTING & POWER COMPANY

STP3054 (4/95)

SOUTH TEXAS PROJECT
ELECTRIC GENERATING STATION

SPECIFICATION FOR

REPLACEMENT STEAM GENERATORS

HOUSTON LIGHTING & POWER CO.

SPECIFICATION NO. **4R129NS1014**

REVISION NO. **0**

REVISION DESCRIPTION

PURCHASE SPECIFICATION: RELEASED FOR FABRICATION

APPROVALS

PED REVIEW REQUIRED? YES ☐ NO ☒ (IF NO, N/A THE COG SEC SUPV APPROVAL)

RPE CERTIFICATION REQUIRED? YES ☐ NO ☒ (IF NO, N/A THE RPE APPROVAL)

RESPONSIBLE ENGINEER D.B. Kemberlain DATE 4/15/97

REVIEWING ENGINEER U. Khan Patel DATE 4/15/97

U. KHAN PATEL

THIS IS TO CERTIFY THAT THIS DOCUMENT HAS BEEN REVIEWED BY ME, THE UNDERSIGNED, AND IS CORRECT, COMPLETE, AND IN COMPLIANCE WITH THE N/A EDITION, WITH ADDENDA UP TO AND INCLUDING THE N/A ADDENDUM, OF THE ASME CODE SECTION III, DIVISION 1 PARAGRAPH NCA-3252 (CONTENTS OF DESIGN SPECIFICATIONS).

N/A	N/A	N/A
RPE	PRINT NAME	DATE

REVIEW PER 0PGP04-ZE-0312 (DESIGN CHANGE IMPLEMENTATION) REQUIRED? YES ☐ NO ☒

N/A	N/A
COGNIZANT SECTION SUPERVISOR	DATE
ac McCluster	4-15-97
SUPERVISING ENGINEER	DATE
[signature]	4/15/97
DIVISION MANAGER	DATE

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DIVISION 100 - GENERAL REQUIREMENTS

101 PURCHASER

Houston Lighting and Power Company
South Texas Project Electric Generating Station

U. S. Mail Address
P.O. Box 289
Bldg. NSC, Mail Stop N4001
Wadsworth, Texas 77483
Attn: Supervisor Nuclear Purchasing

Air Freight Address
8 Miles West of Wadsworth on
FM 521, Matagorda County
Texas 77483
Attn: Bldg. NSC, Mail Stop N4001
Tel (512) 972-7433
Fax (512) 972-7157

102 DESCRIPTION OF PLANT FACILITIES

The following is a brief description of the units requiring Replacement Steam Generators. Performance requirements for each Replacement Steam Generator are given in section 301.12, 304.6 and Supplement A of this Specification.

Utility:	Houston Lighting and Power Company
Facility:	South Texas Project 1 and 2
Location:	8 miles West of Wadsworth on FM 521, Matagorda County, Texas
Capacity:	1250 MWe Net, each unit
NSSS Supplier:	Westinghouse
Steam Generator Model:	E
Commercial Operation:	Unit 1 - August 1988, Unit 2 - June 1989

103 SCOPE

Seller's scope of work shall include design, manufacture, assembly, configuration, documentation, licensing support, testing, field service (two man months; any additional field service support beyond two man months will be at time and material rates), shipping, delivery, etc., as required to allow the Purchaser to receive, store, install, operate, and maintain the Replacement Steam Generators furnished per this specification.

DIVISION 200 - DEFINITIONS, CODES, AND STANDARDS

201 DEFINITIONS

The following terms shall have the meanings given below unless in any particular instance the context expressly indicates otherwise. Words importing person include corporations. Word importing only the singular include the plural and vice versa when the context requires.

ACRS
Advisory Committee on Reactor Safeguards

ANSI
American National Standards Institute

ASME
American Society of Mechanical Engineers

ASTM
American Society for Test and Materials

AWS
American Welding Society

Codes And Standards
"Codes and Standards" means codes, standards or criteria which now or hereafter may be applicable to or affect the manner in which the Work must be designed, installed or tested, including without limitation those published by Governmental Authorities, the American Society of Mechanical Engineers (ASME), the American National Standards Institute (ANSI), and the Institute of Electrical and Electronics Engineers, Inc. (IEEE).

Circulation Ratio
Ratio of mass flow exiting tube bundle to mass flow exiting steam outlet nozzle.

Recirculation Ratio
Ratio of mass flow of condensate exiting separator region to mass flow of feedwater.

Design Life
The design life of a steam generator is the minimum life engineered in the hardware to insure reliable operation under its expected operating conditions.

Equipment
"Equipment" means all equipment, materials, documents, components, and parts to be furnished by the Seller to the Purchaser under this specification for Replacement Steam Generators.

FN
Ferrite Number

Final Delivery
"Final Delivery" with respect to a unit shall occur when all the Replacement Steam Generators for such unit have been received and accepted on site by the Purchaser.

Final Delivery Date
"Final Delivery Date" means the date of Final Delivery at Purchaser's site.

Governmental Authorities
"Governmental Authority" or "Governmental Authorities" means federal, state or local bodies, established by law, including the NRC, which now or hereafter exercise regulatory control over the Work to be performed by the Seller thereunder, the design, construction or operation of the Plant, or the use of environmental conditions of the Site.

Heat
The term "heat" describes material from one single molten batch and a single heat treatment lot (or batch).

Improvement
"Improvement" means any development, improvement or enhancement in the design, manufacture, installation or operation of the Seller's Replacement Steam Generators that improves or is likely to improve its performance or expected life or that reduces the costs of its maintenance or operation.

Lot
The term "lot" describes the subpart to a "heat" and is material from a single heat treatment.

NRC
"NRC" means the Nuclear Regulatory Commission and any governmental agency or body that succeeds to all or any part of its regulatory authority.

OBE
Operating Basis Earthquake

Performance Tests
"Performance Tests" means those tests and performance criteria set forth in Section 306.6 of this specification.

Plant
"Plant" means South Texas Project.

Purchaser
Houston Lighting & Power Company

Purchaser's Authorized Quality Assurance/Quality Control Representative (PAR)
An employee or authorized representative of the Purchaser assigned to confirm adequate implementation of the Seller's QA/QC program for compliance with all applicable QA/QC requirements of this specification.

Purchaser's Shop Inspector (PSI)
An employee or authorized representative of the Purchaser assigned to perform various inspections in the shops of the Seller, or in the shops of the Seller's Suppliers, to ensure compliance with standards and criteria as required by this specification.

Replacement Steam Generators (RSGs)
"Replacement Steam Generators" or "RSGs" means the Replacement Steam Generators and related equipment, materials and documentation to be furnished by Seller to Purchaser under this specification with respect to each unit.

R.G.
Regulatory Guide.

Seller
"Seller" pertains to the successful party in whole, or in part, that has secured the contract for supply of replacement steam generators per this specification.

Services
"Services" means all services, including technical assistance, transportation, shipping and handling, and other actions to be performed by the Seller under this specification.

State
"State" means Texas.

Supplier or Subcontractor
"Supplier" or "Subcontractor" means any vendor, subcontractor or other person, regardless of tier, who supplies equipment, goods, components, parts, materials, information or services to the Seller in connection with the equipment or services furnished by the Seller under this specification.

SSE
Safe Shutdown Earthquake

Technical Assistance or Technical Direction
"Technical Assistance" or "Technical Direction" means technical guidance, advice and counsel, based upon then current engineering, installation, testing, and maintenance practices, given to Purchaser's supervisory staff but excludes any supervision or management of Purchaser's employees, agents, or other contractors as well as direction of plant operations.

Tons
Tons, as used in this specification, are tons in the English system of measurement, NOT metric tons.

Unit
"Unit" means each of the Purchaser's electric generating units in which Replacement Steam Generators will be installed, designated as South Texas Project (STP) Unit 1 and South Texas Project (STP) Unit 2.

Work
"Work" means all services and materials to be furnished by Seller under this specification including the technical direction drawings, information and documentation, equipment, material, and services required to engineer, design, manufacture, supply and support the licensing of the Replacement Steam Generators.

QA
Quality Assurance

QC
Quality Control

202 INDUSTRY CODES AND STANDARDS

202.1 GENERAL

The equipment and other work furnished under this specification shall be in conformance with the requirements of applicable USNRC Regulatory Guides including the following codes, standards and specifications to the extent specified herein. A later version of some of the dated documents may become mandatory under regulations that have jurisdiction. If this develops, the newer version of each document shall be incorporated into a revision to the Certified Design Specification using the process described in Section 301.8. Later versions shall not be adopted unless approved by the Purchaser and incorporated into this specification.

If there is a conflict between this specification and a referenced document, the matter shall be referred to the Purchaser. The Seller shall obtain written resolution of any conflict from the Purchaser prior to proceeding with any work involving that conflict.

The scope of the Replacement Steam Generator Equipment and Service to be furnished by the Seller shall comply with all applicable federal, state and local Codes, standards and criteria. The applicable United States Federal Code and Standard dates are provided as reference. The Seller, unless otherwise stated by the Purchaser, shall use the appropriate codes and standards listed in this section in effect at the time Purchase Order is issued by Purchaser.

The Seller has ultimate responsibility for ensuring the replacement steam generators are built to consistent and applicable codes, standards and NRC regulatory guides required by United States law. Any financial repercussions resulting from incorrect interpretation, misapplication or selection of codes, standards or Regulatory Guides shall be borne by Seller.

202.2 ANSI Standards

ANSI/ASME B16.5,1986, Pipe Flanges and Flanged Fittings (1988 pending NRC Acceptance)
ANSI/B16.11, 1980, Forged Steel Fittings Socket-Welding and Threaded
ANSI/ASME B16.25, 1986, Buttwelding Ends
ANSI/ASME B31.1, 1986, Standard for Pressure Piping
ANSI N45.2.1, 1980, Cleaning of Fluid Systems and associated Components During Construction Phase of Nuclear Power Plants
ANSI N45.2.2, 1972, Packing, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants
ANSI N45.2.3, 1973, Housekeeping During the Construction Phase of Nuclear Power Plants
ANSI N45.2.6, 1978, Qualifications of inspection, examination and testing personnel for Nuclear Power Plants
ANSI N45.2.9, 1974, Requirements for Collection, Storage and Maintenance of Quality Assurance Records for Nuclear Power Plants
ANSI N45.2.11, 1974, Quality Assurance Requirements for the Design of Nuclear Power Plants
ANSI N45.2.12, 1977, Requirements for Auditing of Quality Assurance Programs for Nuclear Power Plants
ANSI N45.2.13, 1976, Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants
ANSI/ASME N45.2.15, 1981, Hoisting, Rigging and Transportation of Items for Nuclear Power
ANSI N45.2.23, 1978, Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants
ANSI/ANS 58.2, 1988, Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture
ANSI/ASME N626.3, 1993, Qualifications and Duties of Specialized Professional Engineers
ANSI/ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities (Edition as specified by ASME Section III Subarticle NCA-4110)

202.3 American Society for Nondestructive Testing (ASNT) Standards

SNT-TC-1A, 1984, Recommended Practice for Nondestructive Testing, as Amended by ASME XI, IWA-2300 for the Inservice Inspection requirements.

202.4 American Society for Testing and Materials (ASTM) Standards

ASTM A262, 1986, Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A380, 1988, Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
ASTM A578M, 1985, Straight Beam UT Exam of Plain and Clad Steel Plates for Special Application
ASTM E3, 1980, Preparation of Metallographic Specimens
ASTM E11, 1987, Standard Specification for Wire-Cloth Sieves for Testing Purposes
ASTM E94, 1989, Guide for Radiographic Testing
ASTM E112, 1988, Estimating the Average Grain Size of Metals

202.5 American Society of Mechanical Engineers (ASME) Codes

ASME Section II, Material Specifications, same edition, addenda as Section III
ASME Section III, Rules for Construction of Nuclear Division 1 Power Plant Components, 1974 edition, no addenda (applicable to original steam generators), 1974 edition, Winter 1975 addenda (applicable to SG supports)
ASME Section III, Rules for Construction of Nuclear Division 1 Power Plant Components, 1989 edition, no addenda (applies to replacement steam generators)
ASME Section III, Code Case N-20-3 SB-163 Nickel-Chromium Iron Tubing (alloys 600 and 690) and Nickel-Iron-Chromium Alloy 800 at a Specified Minimum Yield Strength of 40.0 ksi and Cold Worked Alloy at a Yield Strength of 47.0 ksi Section III, Division 1, Class 1
ASME Section III, Code Case N-47-30 (N-47-23) Class 1 Components in Elevated Temperature Service Section III, Division I
ASME Section III, Code Case N-71-15 Additional Materials for Subsection NF, Classes 1, 2 3, and MC Component Supports Fabricated by Welding Section III, Division 1
ASME Section III, Code Case N-411-1 Alternative Damping Values for Response Spectra Analysis of Class 1, 2 and 3 Piping Section III, Division 1
ASME Section III, Code Case N-474-1 Design Stress Intensities and Yield Strength Values for UNS No. 6690 with a Minimum Yield Strength of 35 ksi, Class 1 Components Section III, Division 1
ASME Section III, Code Case 2142, F-Number Grouping for Ni-Cr-Fe-Class for UNS-N06052 Filler Metal
ASME Section III, Code Case 2143, F-Number Grouping for Ni-Cr-Fe-Class for UNS-W86152 Welding Electrodes

ASME Section V, Nondestructive Examination (year & addenda per referencing code)
ASME Section IX, Welding and Brazing Qualifications (year & addenda per referencing code)
ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1989 edition
ASME Section XI, Code Case N-401-1, Eddy Current Tubing Evaluation

202.6 American Welding Society (AWS) Standards
AWS A2.4, 1986, Symbols for Welding and Nondestructive Testing
AWS A4.2 Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic Stainless Steel Weld Metal (1974)
AWS D1.1, 1990, Structural Welding Code - Steel

202.7 Code of Federal Regulations
10 CFR 21, Reports of Defects and Noncompliance
10 CFR 26, Fitness for Duty for Nuclear Power Plants (personnel on nuclear site)
10 CFR 50, Domestic Licensing of Production and Utilization Facilities
10CFR50 Appendix A, General Design Criteria for Nuclear Power Plants
10CFR50 Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
10CFR50 Appendix G, Fracture Toughness Requirements
10CFR50 Appendix K, ECCS Evaluation Models
10CFR50.46 Acceptance Criteria For Emergency Core Cooling Systems For Light Water Nuclear Power Reactors
10CFR50.55a Codes and Standards
10CFR50.59 Changes, Tests, and Experiments
10CFR Part 73 Physical Protection of Plants and Materials

202.8 U.S. Nuclear Regulatory Commission (USNRC) Regulatory Guides (R.G.)
R.G. 1.29, 1978, Seismic Design Classification
R.G. 1.31, 1978, Control of Ferrite Content in Stainless Steel Weld Metal
R.G. 1.37, 1973, Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants
R.G. 1.38, 1977, Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Water-Cooled Nuclear Power Plants
R.G. 1.39, 1977, Housekeeping Requirements for Water Cooled Nuclear Power Plants
R.G. 1.43, 1973, Control of Stainless Steel Weld Cladding of Low Alloy Steels
R.G. 1.44, 1973, Control of the Use of Sensitized Stainless Steel
R.G. 1.50, 1973, Control of Preheat Temperature for Welding of Low Alloy Steel
R.G. 1.58, 1980, Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel
R.G. 1.60, 1973, Design Response Spectra for Seismic Design of Nuclear Power Plants
R.G. 1.61, 1973, Damping Values for Seismic Design of Nuclear Power Plants
R.G. 1.64, 1976, QA Requirements for the Design of Nuclear Power Plants
R.G. 1.70, 1978, Standard Format and Content of Safety Analysis Reports
R.G. 1.71, 1973, Welders Qualification for Areas of Limited Accessibility
R.G. 1.83, 1975, Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes
R.G. 1.84, 1994, Design and Fabrication Code Case Acceptability ASME Section III, Division 1
R.G. 1.85, 1994, Materials Code Case Acceptability ASME Section III, Division 1
R.G. 1.88, 1976, Collection, Storage and Maintenance of Nuclear Power Plant Quality Assurance Records
R.G. 1.92, 1976, Combining Modal Responses and Spatial Components in Seismic Response Analysis
R.G. 1.121, 1976, Bases for Plugging Degraded PWR Steam Generator Tubes (for comment)
R.G. 1.123, 1977, QA Requirements for Control of Procurement of Items and Services for Nuclear Power Plants
R.G. 1.124, 1978, Design Limits and Loading Combinations for Class 1 Linear-Type Component Supports (applies to existing component supports)
R.G. 1.130, 1978, Design Limits and Loading Combinations for Class 1 Plate- and Shell-Type Component Supports (applies to existing component supports)
R.G. 1.144, 1980, Auditing of QA Programs for Nuclear Power Plants
R.G. 1.146, 1980, Qualification of QA Program Audit Personnel for Nuclear Power Plants
R.G. 1.147, Inservice Inspection Code Case Acceptability - ASME Section XI, Div. 1 (latest revision at time of contract award)

R.G. 8.8, 1982, Information Relevant to Ensuring that Occupational Radiation Exposure at Nuclear Power Stations Will Be As Low As Reasonably Achievable (ALARA)

R.G. 8.10, 1977, Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as is Reasonably Achievable (ALARA)

202.9 Others

NUREG-0484, Methodology for Combining Dynamic Responses, May, 1980

NUREG-0609, Asymmetric Blowdown Loads on PWR Primary Systems, Jan., 1981

NUREG-0800, Standard Review Plan (SRP), July 1981

NUREG-0918, Prevention and Mitigation of Steam Generator Water Hammer Events in PWR Plants, Nov., 1982

SRP 3.9.3, 1981, ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures - including Appendix A (Revision 1)

202.10 Steel Structures Painting Council

SSPC PA1, 1982, Shop, Field, and Maintenance Painting

SSPC PA2, 1982, Method for Measurement of Dry Paint Thickness with Magnetic Gages

SSPC PS 8.01, 1982, Rust Preventive Compounds (Thick Film)

SSPC SP 1, 1982, Surface Preparation Specification No. 1, Solvent Cleaning

SSPC SP 10, 1989, Near White Blast Cleaning

SSPC SP 66, White Metal Cleaning

SSPC Vis 1, 1989, Pictorial Surface Preparation Standards for Painting Steel Surfaces

202.11 Tubular Exchanger Manufacturers Association (TEMA)

TEMA, 1988, Standards, Seventh Edition

202.12 NRC-Branch Technical Position (BTP)

BTP ASB 10.2, 1984, Design Guidelines for Avoiding Water Hammers in Steam Generators

202.13 Electric Power Research Institute (EPRI) Guidelines

NP-3009, Steam Generator Chemical Cleaning Process Development

NP-5652, Guidelines for Utilization of Commercial Grade Items in Nuclear Safety-Related Applications

NP-6201, PWR Steam Generator Examination Guideline, Rev. 2

NP-6406, Guidelines for Technical Evaluation of Replacement Items in Nuclear Power Plants

NP-6617, Electropolishing Qualification Program for PWR Steam Generator Channelheads

NP-6618, Electropolishing Qualification Program for PWR Steam Generator Divider Plates

NP-6737, Cobalt Reduction Guidelines

NP-6743-L, Vol. 2, Guidelines for PWR Steam Generator Tubing Specifications and Repair Specifications for Alloy 690 Steam Generator Tubing

TR-102134, PWR Secondary Water Chemistry Guidelines, Rev. 3

TR-105714, PWR Primary Water Chemistry Guidelines, Rev. 3

DIVISION 300 - TECHNICAL RESPONSIBILITIES

301 SELLER'S RESPONSIBILITIES

The Seller shall design, analyze, manufacture, inspect, test, clean, package and ship complete replacement steam generators, spare parts, shipping/storage cradles, attachments and other equipment/documents as specified herein. The Seller shall furnish the equipment, material, and services as indicated throughout this specification and shall certify that the equipment, material and services meet all requirements of this specification. The Purchaser will unload, store and inspect the equipment for acceptance, furnish normal plant instrumentation and controls and test the steam generator performance for conformance with the requirements of this specification.

The design, fabrication and testing of the replacement steam generators by the Seller shall meet all pertinent criteria in Appendices A and B of 10CFR50 including Generic Design Criteria 1, 2, 4, 14, 15, 30, 31 and 32.

301.1 General

The Seller shall be responsible, in compliance with the requirements of this specification and all referenced documents, for the detailed design, performance analyses, product quality assurance, materials procurement, fabrication, testing, certification, code stamping prior to shipping, examination, inspection, guaranteeing, licensing support, preservice inspection, cleaning, packaging, shipping and delivery of all items included in this specification. The Seller shall also be responsible for designing the RSG so that it is compatible with other related systems, the existing steam generator attached piping and structural support system as well as the RSG containment building compartment and its equipment.

The Seller shall be responsible for developing and providing to the Purchaser all documentation necessary for the fabrication, installation, licensing, and operation of the RSG.

Seller shall establish electronic mail communication with Purchaser and Purchaser's designees. Seller shall be responsible for procurement of the following software and hardware required to interface with Purchaser: Lotus CC Mobile Application (Latest Version), Windows 3.1, Hayes Compatible Modem (14.4k Baud minimum), PC with at least 386 processor. Seller's personnel shall be responsible for equipment setup and operation. Purchaser's technical representative can be contacted through designee listed in section 101.

301.2 Documentation and Submittal Requirements

All documents submitted to the Purchaser shall be in English and shall have an English system of units throughout. All documents submitted to the Purchaser (including referenced documents) shall become the property of the Purchaser. Handling of Seller's proprietary information is addressed by the General Conditions for Contract Services portion of the contract.

For each document required for submittal for Purchaser review, (5) hard copies and (for drawings only) (1) microfilm shall be provided. Documents shall be submitted to a point contact designated by Houston Lighting and Power Company. Electronic media shall be in a format fully compatible with the following software:

CAD: Microstation version 5.0 (.DGN) format. All CAD files shall be supplied on two sets of 8mm tape for UNIX with a threshold storage set at 2.3 gigabytes per tape with labels and directory listing of files contained on the tape. If a different CAD system for producing drawings is utilized, Seller shall be responsible for translating files to the format specified above. Two or three dimensional drawings are acceptable.

Word Processing:	Microsoft Word 6.0 for Windows
Database:	Microsoft Access Ver. 2.0
Spreadsheets:	Microsoft Excel Ver. 4.0a

(Note: Software package upgrades over the life of the plant may be mutually advantageous, and may be implemented if mutually agreed upon without revising this specification.)

For final submittal of all documents required as Seller deliverables, (including documents subject to Purchaser review which have received final approval), the Seller shall provide (3) hard copies as well as electronic media and/or microfilm as mutually agreed. Format for documents, not specified, shall be as mutually agreed.

The Seller shall prepare and submit to the Purchaser, for approval, a Documentation Index detailing all documents including computer software) which will be required to comply with this specification and referenced codes and standards. This Index shall identify, both by document type (e.g. materials test report or PT report) and the specific component or part, each individual document that will be submitted to the Purchaser. This index shall identify the appropriate revision designation and status for each document and be maintained current. The index shall be maintained on an electronic data base and be available to the Purchaser as mutually agreed.

Section 303.4 of this Specification contains additional information regarding document submittal and review requirements.

301.3 Drawings

As a minimum submitted drawings shall include:

1. All physical outlines and general arrangements as required to accurately define or envelope the RSG exterior profile.

2. Cross sections and detail drawings necessary to ensure that all components conform with specification requirements including design and physical arrangement with dimensions and tolerances of each of the RSG internals and the pressure vessel (including nozzles and safe ends). Detail drawings shall indicate material specifications (Description shall include ASTM specification and grade, generic nomenclature such as "carbon steel" is not permitted), weld and other special processes including chromium plating, heat treatment and tube bending and expansions, dimensions and tolerances and shall include drawings of gaskets, gasket seating surfaces tube arrangement, bundle assembly, and miscellaneous components.

3. Design and location including dimensions and tolerances of all interfaces with existing structures, supports, piping, etc. As built dimensions (as defined by the Purchaser) of all interface dimensions, dimensions critical to subcomponent alignment or assembly and all pressure boundary parts shall be provided.

4. Weights and centers of gravity of the dry, operating, and flooded RSGs. Note that dry weight and center of gravity are to be determined empirically.

5. Detail drawings of special features, dimensions and tolerances including provisions for rigging.

6. Shop fabrication and assembly drawings for all parts and assemblies including dimensions and tolerances as well as any other documents referenced by these drawings. (Note: Shop drawings as described above will be submitted to HL&P as the shop operations are completed. The HL&P resident(s) shall be provided access to the current shop drawings, and shall be notified of changes in revision status.)

7. All fasteners shall be fully defined as to nominal size, length, thread pitch and fit (class), dimensional standard, material specification and surface finish specifications.

8. Details of all access penetrations (handholes, manways, etc.) including nominal dimensions, tolerances, surface finish requirements, lubricant specification, and stud torque or elongation range.

9. A complete bill of materials which includes identification of the ASME Code classification of subassemblies, parts or material. Non-Code subassemblies, parts and materials shall be designated as Safety Related (10CFR50 Appendix B applies), Safety Related Commercial Grade, or Non-Safety Related, as applicable.

10. A complete list of recommended spare and replacement parts. It is the Purchaser's intent to require the Seller to submit all drawings associated with the RSG unless the Seller's advice to the contrary is accepted. Specifically, the Seller shall describe any type or classification of drawing which would be of no use to the Purchaser.

Drawing format requirements are specified in Attachment 1, entitled "Seller's Desk Top Instructions For Creating CAD Drawing Files." In addition, the following requirements apply:

Details shall have numerical designations and sections shall have alpha designations.
Drawing scale shall be 1/4" = 1' , 1/2" = 1' or NTS
Dimensions shall be in decimal format with ± tolerances.

301.4 Technical Reports

The Seller shall prepare and submit all technical reports required by applicable codes, standards and this Specification. The following additional requirements apply to technical reports:

1. The reports shall be certified by a Registered Professional Engineer.

2. Input to computer programs shall be included and identified as measured, calculated, assumed, etc. All computer input files shall be provided.

3. The computer programs used in the analyses shall be identified and fully described and qualified/verified. Descriptions of standard programs such as ANSYS, STRUDL, etc., are not required beyond complete identification of the code edition or revision and all modifications utilized. All Seller programs shall be described and appropriate test cases presented to demonstrate validity.

4. Output of Computer Programs - A summary of pertinent results shall be included in the body of the report. Computer output sheets or microfiche shall be included as appendices to the report.

5. The reports shall include drawings and other data necessary for checking the properties, such as structural mass and stiffness, of the equipment analyzed.

6. The data base supporting all analytical models, calculations and methods shall be made available by the Seller for Purchaser's access and review over the design life of the RSG. Copies of such information shall be furnished to the Purchaser at Purchaser's option, and, Seller shall notify Purchaser in advance of any intent to destroy or failure to keep this information.

301.5 Procedures

The Seller shall submit procedures identified by the Purchaser as described in Section 303.4 of this Specification.

301.6 Licensing Support and Topical Report

The Seller shall provide the Purchaser with all necessary technical assistance to enable Purchaser's licensing effort to proceed on an orderly and timely schedule. Technical support, information, data, calculations, analyses, procedures, etc., concerning the supplied equipment and the operation of the nuclear steam supply system and input to plant analyses as required to enable the Purchaser to obtain the necessary permits, licenses, and approvals from applicable regulatory bodies shall be provided by the Seller. This Seller developed information shall be documented by the Seller in a Topical report and submitted for Purchaser approval. As part of this effort, the Seller shall provide the following:

Request for any needed existing and available detail data regarding related plant systems.

The Seller shall describe in detail the licensing approach to be used with the NRC. The Seller shall confirm in writing to the Purchaser, the certainty of licensability of the Seller's Replacement Steam Generators.

The Seller shall provide the analysis and documentation necessary to identify all differences between the proposed Replacement Steam Generators and the original Steam Generators as described in Supplement A and the plant specific UFSAR. The Seller shall demonstrate that these differences do not constitute unreviewed safety questions, as defined in 10 CFR 50.59 or require amendment to the current Technical Specifications. Seller shall supply a draft 50.59 analysis report for Purchaser's use. In conjunction with review of the UFSAR, the Seller shall identify and document all UFSAR revisions required to address the installation of and plant operation with the replacement steam generators. See also Attachment 2, entitled "Licensing Support Program Plan."

In the event that a design change involves an unreviewed safety question, the Seller shall provide the documentation necessary to show that feature of the proposed Steam Generators meets the requirements of the United States Nuclear Regulatory Commission (USNRC). The Seller shall provide a brief description of the effect of the proposed Replacement Steam Generators on the probability of occurrence and the consequences of each accident identified in this specification and the plant specific UFSAR. The Seller shall provide a technically based estimate of the initiating event frequency for a steam generator

tube rupture (SGTR) event and for a steam generator tube leak event. Purchaser shall calculate the impact on the STP Probabilistic Safety Assessment, (if any) and provide that information to Seller to be included in Seller's safety evaluation.

The Seller shall also provide technical data and analyses to fully address the impact of any differences between the RSGs and the existing steam generators on the plant design basis. This includes, but is not limited to, design/geometric/weight/performance data and analyses for use in the plant accident analysis, containment design, attached piping and structural supports analyses, etc.

(Note: The following discussion pertains to piping interfaces where the selected replacement Steam Generator design does NOT require modification to the existing pipe routing.) Seller is to perform all reanalysis required as a result of Steam Generator replacement. This includes all piping directly attached to the RSGs (not limited to the primary loop), and also includes affected piping attached to that piping. Where Seller can demonstrate that the existing piping analysis (e.g., Reactor Coolant System piping, Auxiliary Feedwater piping, Main Steam piping, Steam Generator Blowdown piping, etc.) remains bounding, then reanalysis is not required. If the existing analysis is not bounding, then the piping must be reanalyzed by the Seller. If the reanalysis shows a secondary impact on system(s) connected to the reanalyzed system, then further reanalysis would also be within the Seller's scope. Seller is expected to perform ALL required reanalysis, chasing impacts on the existing design as far as is necessary.

301.7 Integrated Schedule

The Seller shall establish and maintain a fully integrated RSG fabrication schedule. The schedule must be maintained such that accurate and current status of fabrication activities in relation to intermediate milestones and final delivery of the RSGs is available to the Purchaser on a monthly basis or upon request. In addition, the following minimum requirements apply to the integrated schedule:

1. The schedule shall integrate all work (not limited to Purchaser's order) in the Seller's facility for the duration of the Purchaser's contract. Accompanying documentation shall indicate the Seller's adequacy with respect to shop capacity and labor resources to satisfy the Seller's entire work load commitment for the duration of the Purchaser's contract.

2. Use of the schedule shall flag any activity, not normally on critical path, which, through unanticipated circumstances, threatens to become a critical path activity. This information shall also be made available to the Purchaser.

3. The schedule or accompanying documentation shall indicate which activities or operations are to be performed in the general facility and which will be performed in the clean area. In addition, activities which are to be performed by subcontractors or at subcontractors facilities shall be delineated.

4. Information on the status of activities supporting RSG fabrication such as design, analysis, material procurement and fabrication by subsuppliers shall be maintained as current and accurate.

5. The Seller shall provide accompanying documentation to prove, quoting experience, that durations assigned for fabrication activities in the schedule conservatively account for potential rework.

6. The integrated schedule shall be available to the Purchaser on magnetic media (software as mutually agreed).

301.8 Certified Design Specification (CDS)

The ASME Code required CDS shall be derived from this Specification. The Seller, acting as the Purchaser's (Owner's) designee shall prepare the CDS for Purchaser's (Owner's) approval. The Seller shall also provide certification of the CDS by a Registered Professional Engineer, qualified in accordance with ANSI/ASME N626.3 requirements. It is fully intended that the CDS maintain the technical requirements and Seller obligations described in this Specification. It is the Purchaser's expectation that the Seller will adopt this Specification as the functional CDS from the time of contract award until the CDS is developed and approved per code requirements. The Purchaser will not accept a protracted development period on the part of the Seller prior to CDS issuance.

Subsequent revision of the CDS, not initiated by the Purchaser, shall be the responsibility of the Seller, acting as the Purchaser's (Owner's) designee. The Seller shall submit explicit requests for revision to the Purchaser for approval. The Seller shall abide by the same requirement for prompt processing of formal CDS revisions and shall provide certification of CDS revisions by a Registered Professional Engineer, qualified in accordance with ASME requirements.

Any and all design changes that Seller proposes Purchaser to be responsible for after contract award shall be documented and submitted to Purchaser for approval within (14) days of change request. Financial and schedule impact shall be included in this documentation and shall be binding.

301.9 Experience and Reliability Report

In a report, submitted for Purchaser approval, the Seller shall describe all operating and test experience with individual RSG design features and proposed design as a unit. The Seller shall include detailed supporting data to establish the adequacy of the design for the intended service. The report shall identify aspects of the RSG design which provide improved reliability over the existing steam generator and include anticipated failure rates of subcomponents, repair cycles and chemical cleanings based on actual field experience. This report shall be revised as necessary to be current at the time of RSG delivery.

301.10 Technical Manual

The Seller shall provide a Technical Manual which shall include the following information as a minimum:

1. General Requirements

   - Five (5) hard copies and one electronic copy of the manual shall be provided. The electronic copy shall be in Microsoft Word 6.0 (or later) format for word processing and graphics as described in Attachment 1, entitled "Seller's Desk Top Instructions for Creating CAD Drawing Files."
   - Each major section of the body shall be identified with a tab inserted at the starting location of the section.
   - No drawings shall be provided with the manual. ALL drawings shall be provided in accordance with Section 301.3 of this specification.
   - Seller shall agree to participate in the Purchaser's Vendor Equipment Technical Information Program, which requires periodic verification of the accuracy of the documentation associated with the RSGs.

2. Content of introduction shall include the following:

   - Title page which includes: Manual Title, Manual Number, Manual Revision Level and Revision Date.
   - List of affected pages for the manual revision.
   - Table of Contents listing each major manual section and the tab location for each section.
   - List of all drawings provided with the RSGs including the Seller drawing number and drawing title.

3. Content of body shall include:

   - RSG technical data including Design data.
   - RSG component description including all subassemblies and major parts.
   - Installation instructions covering installation, alignment and inspection of the RSG prior to operation.
   - Operating instructions including:

     Complete and detailed instructions for placing the RSGs in service shall be provided including precautions and critical points/parameters to be observed. This includes chemistry requirements and heatup limits as applicable.

     Complete and detailed operating instructions for the RSGs, including chemistry requirements, precautions and critical points/parameters to observed. Possible operational difficulties with probable causes and remedial actions listed shall be included.

Critical limits and precautions shall be clearly indicated by a bold "CAUTION," "NOTE," "DANGER" or "WARNING" notice printed on the page. Cautions, Notes and Warnings shall precede sections or steps to which they apply.

A tabulation of the operating parameters for temperature, pressure, chemistry, circulation ratio, etc., giving values for normal operation (including ranges) and set points for instrument alarms.

Complete and detailed shutdown information for removing the RSGs from service. Information shall include precautions, critical points/parameters to be observed and layup requirements. This includes chemistry requirements and cooldown limits as applicable.

Characteristic curves for the RSG showing Steam Flow vs. Generator Pressure.

- Troubleshooting guidelines - Possible malfunctions, probable cause, method of detection and corrective action shall be provided.

- Maintenance Instructions - Those steps required to open and close RSG accesses shall be provided including fastener torque values, lubricants and procedures. The instructions shall include equipment clearances, tolerances and adjustments required for proper operation. This includes instructions for RSG tube plugging.

- Periodic testing and preventive maintenance - Tests, inspections and parts renewal to be performed with intervals/frequencies shall be identified.

- Spare and renewal parts list - Replacement parts should be listed, including the part name and number, recommended stock quantity and shelf life as applicable. Refer to Section 301.3 items 7 and 9 of this Specification for additional requirements.

- Special tools - Special (non-standard) tools required to operate or maintain the RSGs shall be specified. Drawings or part numbers for the tools shall be provided.

- Storage requirements - The Seller shall provide recommended storage conditions for the RSGs. Any special precautions shall be identified. These recommendations shall address initial site storage prior to installation, as well as long idle periods after RSG installation.

301.11 Interface Requirements

It is the responsibility of the Seller to provide RSGs that accurately match the existing related systems, piping, equipment, supports, and containment structure. Consequently, determination of nozzle locations and all miscellaneous interface points and support locations interface measurements are the responsibility of the Seller. Design approach and fabrication accuracy of the Replacement Steam Generators shall be adequate to match the as-built interface dimensions of the original steam generators. Tolerances shall be as specified in Supplement A, Part C.

Potential exceptions exist as it may be necessary for the Purchaser to reroute supporting systems such as main feedwater or blowdown to accommodate desired RSG design features. In this case, the Seller is only responsible for accurate location and orientation of the RSG connection as approved by the Purchaser.

Since proper fitup is absolutely critical to successful RSG installation, the Seller shall create and maintain a separate interface document with input from the Purchaser.

The document shall accurately describe all RSG nozzle connection locations. Elevations shall be determined from a common RSG datum such as the top of the tubesheet. Radial orientation shall be identified. Distance of nozzle terminal point to RSG true axial centerline shall be identified. The perpendicularity of nozzle axial centerline to RSG true centerline shall also be identified.

In addition to location, nozzle configuration (including OD, ID, counterbore diameter and depth, etc.), nozzle material, weld buttering material and length, safe end material and length and any end preps shall be described in the document.

301.12 Performance Guarantees

The Seller shall guarantee the nominal performance of the new and clean RSG as indicated by the parameters specified in this section. Testing of RSG performance shall be performed by the Purchaser and witnessed by the Seller.

A. Each RSG will generate steam which meets or exceeds the pressure and flow rate requirements when supplied with reactor coolant and feedwater at the full load conditions. Specific requirements are as follows:

Test parameters to be measured

Secondary Side:
- Feedwater Flow
- Steam Flow
- Blowdown Flow
- Feedwater Temperature
- Steam Pressure at 2 points, downstream of steam outlet nozzle calculated from Isolation Valve Cubicle (IVC) pressure and steam generator steam drum pressure, both shall be corrected for flow losses in order to determine the steam pressure immediately downstream of the steam nozzle flow restrictor. Purchaser and Seller shall mutually agree on the hydraulic correlation to be used to correct for piping flow losses between the steam generator exit and the measurement locations.

Primary Side:
- Average Cold Leg Temperature
- Average Hot Leg Temperature

Test requirements

1. Steady state operation is to be established with a continuous 100% power duration of at least 12 hours.

2. Feedwater or steam flow rate to be measured with calibrated venturi in accordance with ASME code requirements with the exception that the current configuration with respect to the venturi position is acceptable.

3. Secondary side calorimetric heat balance is required to confirm 100% power.

4. RCS flow rate to be determined by a heat balance using heat duty established from secondary side.

5. Measurement and analytical uncertainty shall be assessed to favor compliance with performance guarantees except as noted below. Determination of measurement uncertainties will be in accordance with ISA 67.04. Assessment of uncertainties will be mutually agree upon.

6. Acceptance Criteria shall be as follows:

   a. Initial Performance Test: The 100% load steam pressure shall meet or exceed the pressure obtained from Table 6-1 below using the T_{hot} reached to produce 100% load. The minimum feedwater temperature shall not be less than 438°F for the performance test.

REPLACEMENT STEAM GENERATOR WARRANTED PERFORMANCE

Hot Leg Temperature (T_{hot}) (in °F)	Warranted Steam Pressure (in psia)
616.0	1013
618.0	1033
620.0	1052
622.0	1073
624.0	1093
626.0	1113

b. Long Term Performance: T_{hot} shall not exceed 626°F to achieve 1040 psi steam outlet pressure at 100% load.

If necessary, the actual steam pressure obtained from the initial and long term performance tests shall be corrected to account for tubes taken out of service through no fault of the Seller. The correction factor shall be 0.0264 psi per tube.

B. Steam moisture content shall not exceed an average value over the four steam generators of 0.10% at the replacement steam generator exit at 100% rated power operation. The steam moisture content performance test shall be performed at 100% rated power operation using Sodium 24 radiotracer or Lithium non radiotracer in accordance with the ASME Performance Test code PTC 6-1976 Section 4.109 or later year as mutually agreed. If the Purchaser chooses to perform the Lithium test and the test fails, the Seller may request that the Purchaser reperform using the Sodium test. The steam sampling location shall be downstream of the steam outlet nozzle. The steam sampling shall be in accordance with ASTM requirements, "Method of Sampling Steam," D-1066. The physical configuration of the plant is acceptable to Seller for performing these subject tests. Measurement and analytical uncertainty shall be assessed to favor compliance.

C. Water level periodic fluctuation shall be measured using the narrow range water level instrumentation. The acceptance criterion shall be that the steam generator performance does not produce a maximum adjacent peak to peak amplitude fluctuation of 2.0 inches under steady state conditions at any power level up to and including 100% power. As part of the design process, Seller will compare level stability in similar operating feedring generators and determine expected water level fluctuation in the STP generators. If it is determined that the original specification fluctuation amplitude of 1.2 inches can be met, then the criterion will not be revised to 2.0 inches. If the criterion is not likely to be met, and if design modifications that would be necessary to meet this criterion might compromise other aspects of the overall generator design, then the Seller and Purchaser will mutually evaluate and agree on an adjustment to this criterion. In no case will the criterion be increased beyond 3.0 inches. Measurement and analytical uncertainty shall be assessed to favor compliance.

D. The prevention of damaging water hammer for all feedwater flow conditions and all normal and upset operating conditions as defined by the transients to be included in the Certified Design Specification is guaranteed. No specific test for this guarantee is prescribed other than water hammer monitoring during power maneuvering through normal operational transients in accordance with prescribed feedwater water level program control. Damaging water hammer shall be defined as water hammer occurring within the RSG causing plastic deformation in RSG or attached components or piping. The steam generator design and feedwater piping shall be designed using NUREG-0918. This guarantee applies only to water hammer shown to be caused by steam generator design.

E. The data collected from the thermal testing as described in 301.12.A above is used for the determination of the subject guarantee. Reactor Coolant System Flow shall not be less than 102,500 gpm or greater than 106,600 gpm. Measurement and analytical uncertainty shall be assessed to favor noncompliance. (This method of including uncertainty is used to be consistent with operability/Technical Specification requirements for incorporating uncertainties for values at the limits of the license/design basis. It does not impact the ability to use 626°F if necessary to achieve warranted pressure.) The geometric configuration of the steam injection and sampling arrangements in the plant is acceptable.

301.13 Project Management

The Seller shall assign, as a minimum, a project manager dedicated solely to, and wholly responsible for, the Purchaser's order. The project manager shall be readily available so as to adequately fulfill the function of information conduit between Purchaser and Seller. As such, the project manager shall be responsible for maintaining current information on all aspects of the project status including fabrication in house, design, material procurement and fabrication work of subsuppliers. Further, the project manager shall exercise foresight in the identification of circumstances which could potentially result in adverse impact to the quality or delivery schedule of the RSGs. Finally, the project manager shall be granted the authority to implement actions necessary to secure the quality and scheduled delivery of the RSGs. It shall be understood that from the Purchaser's orientation, the project manager functions as much as a representative of the Purchaser as of the Seller.

The project manager shall conduct periodic project status meetings with Purchaser's representatives as mutually agreed. The project manager shall also furnish monthly status reports with format to be approved by the Purchaser. If particular items or operations are identified as behind schedule on two consecutive status reports, the project manager shall submit a formal recovery plan to the Purchaser.

301.14 Field Services

Seller shall furnish the following:

A. The services of competent technical personnel to provide advice, assistance and guidance in the unloading of the equipment furnished under this Specification.

B. The services of competent technical personnel to provide advice, assistance and guidance in the erection of the equipment furnished under this specification.

C. The services of competent startup engineering personnel at the jobsite to start up system, instruct, advise, and train Purchaser's personnel in the correct startup, safe operation and maintenance procedures, testing, and checkout of the equipment. Seller's startup engineers shall be familiar with the equipment and shall be authorized to resolve preliminary operating and interface problems as they develop until satisfactory operation is achieved. Field technical services to correct manufacturing and design errors/deficiencies shall be at the Seller's expense, but with the Purchaser's final approval of the techniques, equipment and methods used.

D. Seller's field personnel shall be capable, qualified, and able to perform the duties required to the satisfaction of the Purchaser and shall be vested with authority to make decisions binding on the Seller.

301.15 Computer Software

The Seller shall recommend and furnish computer software for Purchaser's future use during RSG operations as mutually agreed. As a minimum the Seller shall provide qualified/verified computer software and object code customized such that the thermal hydraulic characteristics of the RSG are accurately modeled. Where Seller utilizes a code commercially available to HL&P, Seller shall provide the geometry files specific to the replacement steam generator configuration used in Seller's analysis and any change to those codes made by Seller.

The list of computer codes in Attachment 3 has been reviewed and pre-approved for use on this project, subject to the following clarification. Seller shall modify the ATHOS code or procure new ATHOS code version to account for heat transfer through the tubesheet. If Seller uses a version of the ATHOS code which has been custom-amended (e.g., to include heat transfer via the tubesheet) by Seller, then object code as well as geometry files will be supplied. If Seller uses an unamended version of the ATHOS code available to HL&P, then only the geometry files will be supplied. Seller shall supply object code for the other codes listed in Attachment 3.

301.16 Simulator Input

The Seller shall provide input necessary to revise the plant simulator model to reflect changes in operating characteristics imposed by the RSGs.

301.17 Photographs

The Seller shall furnish photographs (with suitable identification and parts descriptions) representatively depicting each part and assembly/sub-assembly at each stage of fabrication, assembly, test and shipping. One album, typical of all steam generators, shall be supplied. Photography/videotaping of the fabrication processes is not required. Purchaser shall be allowed to specify what photographs are to be taken.

301.18 Archive Samples

All archive material samples shall be from the same heat/lot as materials in the RSG and marked with the material suppliers' or material manufacturers' heat/lot number in order to maintain sample traceability to the applicable certificates of compliance. All other documentation required in the data report for the part represented by the archival sample shall be supplied for the material samples, in addition, all archive material and part samples shall be provided with an indexed inventory list prior to release. The materials shall have received the same heat treatment as the materials in the RSG. Archive base metal and weldment sample requirements are identified in Attachment 4. Documentation shall include material test reports, furnace time/temperature charts and NDE tests.

The Seller shall provide wooden boxes for storage of archive samples at the Purchaser's site.

301.19 Associated Hardware

The Seller shall supply hardware associated with the RSG as described within this Specification. Associated hardware includes but is not limited to:

- Tools and fixtures (loan)
- Spare parts
- Accessories
- Archive samples
- Mockup
- Insulation (option)

302 PURCHASER'S RESPONSIBILITIES

302.1 Access for Onsite Inspection

The Purchaser shall provide access for onsite inspection to all areas where the Replacement Steam Generator equipment and accessories will be located. Scheduling around plant conditions is required, necessitating cooperation on behalf of the Seller.

302.2 Seller Contact of Purchaser's Representative

During the onsite inspection and during the Work, Seller's Technical Service Representative shall be in contact with the Purchaser's representative, who has overall responsibility in overseeing and coordinating the Work to be performed by the Seller.

302.3 Periodic Manufacturing Inspection

The Purchaser will participate in periodic manufacturing inspection of the work in regards to hold points, notifications, record reviews, approval and other types of design and manufacturing quality verification on the Replacement Steam Generators as delineated in this specification.

303 QUALITY ASSURANCE REQUIREMENT

Addressing the Seller's QA program in the most general manner, it is the responsibility of the Seller to prove, to the Purchaser's satisfaction, that product quality shall never be compromised or subjugated to schedule concerns or unanticipated costs to the Seller. The Purchaser formally declares the position that all rework is the responsibility of the Seller and any off-design conditions or schedule delays are, unacceptable to the Purchaser.

It shall also be proven, to the Purchaser's satisfaction, that all personnel having a part in the fabrication of the RSG assume responsibility for the quality of the product. All personnel should have direct, uninhibited input with regard to problem resolution and process improvement. In other words, the Seller shall prove adoption and implementation of the position that quality is an integral part of the fabrication process and not a commodity that can be added to a component through inspection.

303.1 Seller's QA Program

For all safety-related Work covered under this specification, there shall be in effect a written Quality Assurance (QA) Program, which shall comply with the provisions of 10CFR50 Appendix B and ASME Code Section III NCA-4000. In addition, NQA-1 shall apply to safety-related code items. Non-code safety-related items shall comply with the requirements of 10CFR50 Appendix B. Metallic material organizations are exempt from NQA-1 requirements per NCA-4131. ASME qualified material organizations (QSCs) are to the requirements of NCA-3800.

The Seller's QA program shall ensure that these requirements are extended to all applicable subtier procurements of items and/or services. In addition, Seller's QA Program shall comply with the applicable provisions of the ANSI Quality Standards listed in Section 202.2 of this Specification, as modified by the identified Regulatory Guides (latest edition, unless specified otherwise by the Purchaser).

Regulatory Guide	ANSI Standard	Regulatory Guide Title
1.37	N45.2.1	QA Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants
1.38	N45.2.2	QA Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water Cooled Nuclear Power Plants
1.39	N45.2.3	Housekeeping Requirements for Water Cooled Nuclear Power Plants
1.58	N45.2.6	Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel
1.88	N45.2.9	Collection, Storage, and Maintenance of Nuclear Power Plant QA Records
1.64	N45.2.11	QA Requirements for the Design of Nuclear Power Plants
1.144	N45.2.12	Auditing of QA Programs for Nuclear Power Plants
1.123	N45.2.13	QA Requirements for Control of Procurement of Items and Services for Nuclear Power Plants
1.146	N45.2.23	Qualification of QA Program Audit Personnel for Nuclear Power Plants

Seller's QA Program shall include provisions to extend these quality program requirements to subtier procurement of the items and/or services commensurate with the scope and complexity of the subtier procurement.

303.1.1 QA Program Manual

Seller's QA Program Manual shall be in compliance with 10 CFR 50, Appendix B, ANSI N45.2, ASME NQA-1, 2 (as applicable) and ASME III and this Specification, as a minimum. When submitted, Seller's QA Manual shall be accompanied by a letter signed by an authorized official of the Seller's company specifically stating compliance and identifying those parts or services, if any, not covered by the specified codes and standards. The entire QA Program submitted shall be subject to Purchaser's approval prior to implementation of Contract. After Purchaser's approval, should changes become necessary, the Seller shall prior to implementation, submit such changes to the Purchaser for review and approval.

303.1.2 Company's Right to Access

Purchaser's representatives shall be allowed access to the shops, working areas, and engineering offices of the Seller and its subsuppliers at any time for the purpose of inspections and audits of all activities to ensure compliance with the requirements of the Seller's and supplier's/subcontractor's Quality Assurance Program and all requirements of this Specification. Such inspections and audits will include examination of documentary evidence of activities affecting

quality and will be carried out during the course of the Work to verify compliance with all aspects of the program and to determine the effectiveness thereof.

In addition, the Purchaser retains the right to assign dedicated representatives to the Seller's manufacturing facility on a full time basis. Should the Purchaser exercise this option, the representatives shall be permitted unescorted access throughout the facility and be provided with essential administrative hardware sufficient for three full time resident representatives (i.e. office space, desks, phones, access to copier and fax machines.)

All subcomponents on the shop floor pertaining to Purchaser's contract shall be clearly marked during all phases of the manufacturing sequence to assist in identification of parts. At a minimum, the project name, unit number and steam generator number shall be displayed (e.g. - STP Unit 1, SG#3).

303.1.3 Material Control and Identification

The Seller shall establish and maintain a system for the identification and control of materials, parts, and components, including tubing and partially fabricated assemblies. These measures shall ensure that identification of the item is maintained by part number, serial number, or other appropriate means, on the item and on records traceable to the item throughout fabrication, shipment, and use of the item. These identification and control measures shall be designed to 1) prevent the use of incorrect, defective material, parts, and components and 2) provide traceability of all parts and components to specific manufacturer, heat number, lot number, material test reports and to the Purchase Order number. In the event of defective material, parts and components, records must include the ultimate disposition of the component to ensure incorrect or defective material is not used in the RSG.

The extent to which non-code safety related parts of the steam generator will be documented for materials traceability to Certified Material Test Reports shall be identified by Seller.

The Seller shall provide complete and accurate tube material records which relate each tube, as identified by RSG row and column numbers, to its heat and lot numbers, detailed manufacturing history (including all fabrication, tube reduction and heat treatment steps and deviations from normal practices from melting to final assembly/inspection), and material certifications, including chemical and physical properties. The Seller shall supply this information in the form of a computer database with readily obtainable hardware/software as mutually agreed with Purchaser.

These identification and control measures shall also be designed to preclude retention of foreign objects in either the tube side or shell side when the Replacement Steam Generator is shipped. As a minimum, these procedures shall include detailed accountability procedures for all tools and equipment used during manufacture, appropriate controls on foreign objects such as eye glasses and welding rods, cleanliness requirements, and accountability procedures for any temporarily installed devices.

303.1.4 Seller's Responsibility for Subsuppliers

Since the Seller retains full responsibility for all aspects of subsupplier performance (including quality and schedule), the Seller shall ensure that adequate and periodic audit and surveillance of the subsupplier is maintained, as necessary. Further, the Seller shall ensure, through adequate staffing, that such surveillance, including hold or notification points in particular, does not adversely impact subsuppliers' schedules.

The Seller shall identify to all subsuppliers, all applicable Quality Control (QC) and Quality Assurance (QA) requirements imposed by the Purchaser's specification on the Seller and shall ensure compliance thereto. Purchaser's right of access to the Seller's Supplier facilities for the purpose of inspection or audit shall be imposed by Seller's documents.

The Seller and subsuppliers are subject to audits, inspections, and witnessing by the Purchaser's Authorized Representative to verify compliance with the requirements of the specification, codes, drawings, Purchasing documents and submittals approved by the Purchaser. The PAR's exercise of, or decision not to exercise, the right to inspect, witness, or audit, and any subsequent approval by the PAR, shall not relieve the Seller of his obligation to comply with the terms and conditions of the purchase order or contract. Any request for approval of deviations or nonconformances to the purchase order or contract documents shall be processed in accordance with this Specification.

303.1.5 Submittal of Manufacturing and Inspection Plan

After award of a purchase order, and prior to the Preproduction Review Meeting, the Seller shall submit copies of the Manufacturing and Inspection Plan for his shop and those of subsuppliers to the Purchaser, for information and subsequent establishment of Notification Points. An integral part of the manufacturing and inspection plan shall be the integrated schedule identified in Section 301.7.

In addition, as a minimum, the Manufacturing and Inspection Plan shall outline the basic manufacturing and production sequence, specific preplanned Seller inspections that are required to be performed, and identify any operations which present potential adverse quality or schedule impact by nature of the Seller's inexperience with the operation or aspects of the operation. The Seller shall update the manufacturing and inspection plan (including the integrated schedule) and submit copies to the Purchaser should there be an approved revision to the manufacturing process. The Purchaser will utilize the plan and requirements of this Specification to establish Notification or Hold Points for surveillance and Purchaser's approval in accordance with Sections 303.2.1 and 303.2.2.

303.1.6 Preproduction Review

Prior to the ordering of materials and/or start of fabrication, the Seller shall review the purchase order, specification, other contractual documents, and its QA Program with the Purchaser. The Seller shall demonstrate its understanding of the quality and QA requirements in the specification and present its methods of complying with those requirements. The Purchaser will approve all methods to be employed by the Seller to meet the requirements of this Specification and Purchasing documents.

303.1.7 Dedication of Commercial Grade Items (Applicable to Safety Related Noncode Parts only)

The Seller shall be responsible for the identification of any items which are, by definition, Nuclear Safety Related, but which can not be procured as such and must be subject to Commercial Grade Dedication as prescribed in EPRI Guidelines NP-5652 and NP-6406. Purchaser approval is required prior to the use of such material, contingent upon Seller's submittal of currently approved program and practices for Commercial Grade Dedication. Fabricated non-Code assemblies shall not be processed as Commercial Grade Items.

303.2 Inspections

Seller shall provide Purchaser with access to its facilities relating to the design, manufacturing and assembly of the steam generator equipment, subcomponents and accessories for purpose of audits and inspections. Purchaser's access may be unscheduled or scheduled. The scheduled access to Seller's and subsupplier's facilities shall be governed, as a minimum, by the required notification points and hold points.

303.2.1 Notification Points

The Purchaser will establish notification points for which the Seller shall give prior notification to the Purchaser. Notification points will be selected by Purchaser based on Seller's detailed schedule and Manufacturing and Inspection Plan. Notification points shall be those dates where the Purchaser has the opportunity to be present at Seller's (or Subsupplier's) facilities to witness a particular phase of the Work related to the Steam Generator equipment, subcomponents, and/or accessories. In addition, the Purchaser may establish temporary notification points if necessary to ensure resolution of temporary quality problems. Notification points require receipt of formal notification at least seven working days in advance of the scheduled time of performance. In no case shall the Purchaser be responsible for a schedule delay due to inadequate or inaccurate Seller notification of an impending activity requiring Purchaser notification. The Purchaser may require that activities performed without proper notification be repeated for PAR observation at the Seller's expense. The PAR will witness the event or will authorize the Seller to proceed without Purchaser's witnessing of the event.

303.2.2 Hold Points

Hold points are considered to be those tests, inspections, and operations which require witnessing by the PAR, shall be incorporated directly into Seller's work control documents and beyond which operations shall not proceed without written consent of the Purchaser. The Seller's failure to stop at a hold point will be cause for the rejection of those items at the Seller's expense for which notification was not provided and/or which were not held. Hold points require receipt of notification at least seven (7) working days in advance of the scheduled time of performance. The Purchaser shall retain the option to require that activities performed without proper notification and/or not held be repeated for PAR observation at the Seller's expense.

The following minimum hold points for which prior notification is required are mandatory:

a) Manufacturing and inspection plan.

b) First vendor shipment of tubes, channel heads, shell and nozzle material.

c) Check of critical dimensions.

d) Preproduction tubing run completion.

e) Verification of Seller's Volumetric Examination Procedure.

f) First time radiography (for compliance).

g) First time ultrasonic testing (for compliance).

h) First piece tube bend test (thickness, ovality, and buckling).

i) Tubesheet and support plate, tube hole drilling inspection.

j) Tube expansion to tubesheet.

k) Initial tube insertion into the support system.

l) Initial AVB installation into the tube bundle.

m) First piece tube-to-tube sheet welding.

n) Welded tube joint helium leak test.

o) First completed tube support.

p) Tube mill eddy current inspection.

q) Final fabricator's shop eddy current inspection.

r) Final hydrostatic test.

s) Shipping release.

t) Additional test, inspection or operation as determined by Purchaser.

303.2.3 Stop Work Action

The PAR will orally notify, and confirm in writing to the Seller any situation, where, in the judgment of the PAR, the Seller or Seller's Suppliers are performing work contrary to the conditions and terms of the procurement documents, or where continued operations could cause damage to, preclude further inspection of, or render remedial action ineffective for any product or service provided by the Seller or Seller's Suppliers.

If, after this notification by the PAR, the Seller does not commence appropriate corrective action to the satisfaction of the PAR, the PAR, by acting through procedures previously established by the Purchaser, will initiate stop work action on the specified product or services and so verbally confirm this to the Seller. The Seller shall cease subject work within one (1) hour of confirmation by the PAR.

Upon receipt of a Stop Work Directive from the Purchaser, the Seller and the Seller's Suppliers shall cease operations, including shipments, on any specified product or service to the extent stipulated by the Stop Work Directive. Resumption of operations shall not be undertaken until the Seller has obtained a written authorization from the Purchaser. The written authorization to resume further operations will be granted only after receipt and approval of the Seller's written commitment to correct, and as appropriate, confirmation of actual correction of, those conditions itemized on the Stop Work Directive.

303.2.4 Seller's Responsibility

It is not intended that the PAR relieve the Seller in any way whatsoever of its obligation to maintain an adequate test, inspection, and documentation program, or of any obligation under this specification. Furthermore, the fact that Purchaser's representatives may inadvertently overlook a deviation from some requirement of this specification shall not constitute a waiver of that requirement, or of the Seller's obligations to correct the condition when it is discovered, or of any other obligations under this specification.

303.3 Release for Shipment

No shipments of assembled RSGs, completed accessories or parts directly to the Purchaser shall be made without inspection, review and approval of the affected items as appropriate, the complete itemized and indexed documentation package and written release or waiver from the PAR. A QA Certificate of Compliance, when accepted and signed by the PAR, will constitute this written release. The Seller's completed Certificate of Compliance must be included in each shipment. These requirements also apply to shipments from the Seller's suppliers when item(s) are to be shipped directly to the Purchaser.

303.4 Procedures, Reports, and Drawings

Unless specified otherwise by the Purchaser, all procedures, reports and drawings associated with the fabrication of the RSG shall be submitted to the Purchaser for approval prior to implementation of the activity addressed by the subject document.

In order to minimize the impact of the approval effort and expedite RSG fabrication, the Seller shall, prior to the preproduction review, submit to the Purchaser, a list of procedures, reports and drawings identified by experience and this Specification to be necessary for RSG fabrication. The list shall contain adequate description to enable the Purchaser to establish the content of each document. The Purchaser shall review the subject list and identify documents specifically exempt from approval and/or establish a clear criterion to establish those documents for which Purchaser approval is required. Documents generated after initial review shall be subject to Purchaser review according to the established criterion.

For documents submitted by the Seller for Purchaser approval, the Purchaser shall, after review, document the approval or any comments and/or exceptions. The Seller shall subsequently document and return responses which specifically address the Purchaser's comments and exceptions. The Seller assumes full responsibility for the satisfaction of the Purchaser's concerns prior to the implementation of the related activity.

All revisions to documents which address Purchaser comments and exceptions shall specifically annotate the source of the revision (by reference to the associated document as identified by the Purchaser) in the document revision record which must be integral to all documents.

303.5 QA Documentation

All QA documentation associated with the Replacement Steam Generator equipment and accessories shall become the property of the Purchaser as received upon completion.

303.5.1 Material Reports and Certificates of Conformance

This specification itemizes certain key steps that shall be witnessed, performed, or verified by the Purchaser at the appropriate times to ensure equipment or material supplied is in conformance with the requirements of this specification. A "Certificate of Conformance" and test reports shall be submitted by the Seller stating that the equipment is in conformance with the requirements of this specification and other applicable requirements. The Seller will not only be required to certify the compliance of his own actions, but those of subsuppliers employed.

The Seller and suppliers shall provide the PAR a formal "Certificate of Conformance" stating that all applicable standards, specifications, codes, and procedures have been complied with.

The Supplier's standard "Certificate of Compliance" form shall be utilized to fulfill the above requirements.

The Seller and the Seller's suppliers shall ship, with the Replacement Steam Generators, all documentation to support the facts certified in the "Certificate of Compliance."

Material Test Reports and Certificates of Conformance for ASME Code items shall, as a minimum, conform to the ASME Code. Certified Material Test Reports and Material Manufacturers' and Materials Suppliers' Certificates of Conformance shall appropriately document the Quality System Certificate Numbers or otherwise indicate that the material was manufactured or supplied under a quality system reviewed and approved by the Seller or appropriate subsupplier holding ASME N-Stamp Certification.

303.5.2 Records Systems

A records system shall be established and maintained by the Seller to provide documentary evidence of the quality of items and activities affecting quality. The quality assurance (QA) records shall include, as a minimum, results of reviews, inspections, tests, audits, monitoring of work performance, and material analyses. Records shall, as a minimum, identify the Purchaser's name, Purchaser's order number, inspector or data recorder, date inspection was performed, type of observation, procedures used, results, acceptability, and action taken with any deficiencies noted. Records of inspection shall also include identity of drawings and procedures utilized, along with the revision level. Additional records on supporting data shall also be maintained. All quality verification records, procedures, and qualifications shall be identifiable to the item or activity involved. These records shall be retrievable and available for examination. Collection, storage and maintenance of records shall be in accordance with the requirements of ASME NQA-1, ANSI N45.2.9, and R.G. 1.88.

303.5.3 Documentation Checklist (Index)

Prior to the start of fabrication, the Seller shall prepare and submit to the Purchaser, for review and approval, a preliminary Documentation Checklist (Index) detailing the Quality Assurance documents which will be required to comply with this specification, with applicable referenced codes and standards. This Checklist shall be itemized by document type, for each component or part, and shall include documents that will be submitted to the Purchaser for information or approval and records which will document the results of operations, inspections, and tests. Upon completion of equipment fabrication, testing, and inspection, but prior to release for shipment, the Checklist shall be finalized to show the drawings and procedures actually used and the records which will document the results of all inspections and tests performed. The final Documentation Checklist shall be verified for accuracy and completeness and submitted to the PAR.

This specification requires specific documents to be formally submitted to the Purchaser for information or review and approval. If these documents are changed subsequent to submittal, the Seller shall resubmit the revised document(s) to the Purchaser for information or review and approval consistent with the original requirement. Any document required by this specification which is produced by a Supplier of the Seller shall first be reviewed and noted as being approved by the Seller and then submitted to the Purchaser for review and approval.

303.5.4 Deviation or Nonconformance Reports

Any deviations or design changes which are not in accordance with the technical or quality assurance requirements of the procurement documents (excluding applicable Codes, Standards and Regulations, which shall not be violated under any circumstances), approved drawings, which the Seller desires to accept, must be approved by the Purchaser. Any such deviation request must be made in writing prior to disposition by means of a Nonconformance Report (NCR) submitted to the Purchaser for approval prior to continuing work. The Seller retains full responsibility for any retest, analyses or rework required to satisfy the Purchaser, without adverse impact to quality or RSG delivery schedule. The Seller shall submit, to the Purchaser's general office representative, all other NCRs which require repair or rework to achieve compliance with the Certified Design Specification, procurement documents or Purchaser approved Seller documents such as procedures or drawings. In addition, ALL NCR's must be reported to the PAR for information.

The Seller shall (1) segregate the nonconforming item to prevent any further processing which may result in a change of the nonconformance as identified, (2) make the NCR available to the responsible Purchaser's inspector for review to ensure the nonconformance is completely identified and accurately stated, and (3) transmit the NCR with recommended disposition to the PAR in an expeditious manner. The Seller shall provide technical justification for the recommended disposition. The Purchaser reserves the right to reject any rework or repair NCR item dispositions which the Purchaser deems inappropriate.

Further engineering and/or manufacturing after detection of nonconformances, prior to Purchaser's approval, shall be at the Seller's risk. The requirements of the specification are binding; no departures are acceptable without the prior consent of the Purchaser. The resolution/approval of Deficiency Notices, Nonconformance Notices, Field Change Notices, etc., must be approved in advance by the Purchaser.

The NCR shall provide the method by which the Seller shall obtain a documented response and approval from the Purchaser when nonconformances are identified. The use of the NCR will pertain to work at the Seller's and subsupplier's shops.

Once an item is identified with an NCR, that NCR shall remain assigned to that item permanently and (future) Purchasers shall be advised of the originating NCR.

The Seller shall comply with NRC Regulation 10 CFR 21, "Reporting of Defects and Noncompliance," as it may be amended from time to time. In addition, Purchaser requires the following:

a) Seller shall within 15 days after execution of the contract is signed by both parties, advise the PAR in writing of the individual who qualifies as the Seller's "Responsible Officer" and who shall have the responsibility for coordinating and implementing the requirements of 10 CFR 21.

b) Seller shall develop and implement procedures in accordance with 10 CFR 21 requirements as applicable to the work under this specification.

c) Evaluations which identify reportable defects as defined in 10 CFR 21 shall be reported by the Seller to the Purchaser within the times prescribed by 10 CFR 21. Defects which cannot be determined by the Seller to be reportable to the NRC shall nevertheless be reported to the Purchaser.

d) Seller shall pass on to his subcontractors and required passing on to subsequent levels of procurement all appropriate requirements of 10 CFR 21.

e) Seller shall notify the PAR of all 10 CFR 21 reports made by any tier of his subcontractors or Suppliers.

f) All NCRs shall be appropriately categorized, trended (to the Purchaser's satisfaction) and reported periodically (bimonthly as a minimum) to the Purchaser.

g) Trends identified by the Seller and/or Purchaser shall be cause for the initiation of a higher tier action than the NCR. Action shall involve the Purchaser and Seller's senior management and include generic assessment of root cause and appropriate measures to eliminate recurrence.

h) RSG delivery documentation shall include clear identification and description of every NCR associated with a particular RSG.

303.5.5 Seller's Documentation

Quality Assurance (QA) documents are a deliverable item. The Seller's QA Representative shall approve them, then present them to the Purchaser. The Seller shall assemble all QA records into two identical sets. Each page of each document submitted shall be clearly identified by the Purchaser's name, the station and unit, the purchaser order numbers, the equipment identification, and the manufacturer's name. Documentation shall meet the requirements of Sections 301.2, 301.3, 301.4, and 301.5. Documents that have been submitted with a previous shipment shall not be duplicated; however, a statement shall be furnished to the Purchaser itemizing, by document, the documents previously furnished for each item of equipment and the date of that previous submittal.

303.5.6 Final Inspection and Check of Records

The Seller shall be responsible for inspecting the item(s) and checking the applicable records, prior to shipment, to verify that all specification requirements have been met. Two complete sets of all documents required to comply with this specification shall be submitted to the PAR. Acceptance of the completed sets of records does not relieve the Seller of responsibility for compliance with specification requirements.

After completion but prior to submittal of these records, the Seller shall complete and submit a Certificate of Compliance. The Certificate of Compliance is a document which certifies that the inspection(s) and test(s), required by the specification, have been satisfactorily completed and the Seller's documentation for that shipment conforms to the procurement document requirements, this specification, and applicable codes and standards. The Certificate of Compliance shall be completed and signed by the Seller's Quality Assurance representative and submitted to the PAR, together with the other documentation applicable to that shipment.

303.6 Test Control

The Seller shall establish a program to assure that all required testing is identified and performed in accordance with written test procedures. The procedures shall incorporate the requirements and acceptance limits contained in applicable design documents, including codes and this specification.

304 TECHNICAL REQUIREMENTS FOR MANUFACTURE AND DELIVERY

304.1 Function

The RSGs shall be fully capable of being operated at up to maximum plant power levels of 3821 MWt (100% power). The RSGs shall be fully compatible with all interfacing and affected plant systems including the reactor coolant, steam, feedwater, auxiliary feedwater, SG water level control, wet layup, shell sampling and blowdown systems. In addition, it is desired that the RSG provide enhanced capability with regard to steam generator performance, reliability, maintainability and tube plugging margin as identified in subsequent paragraphs of this specification.

304.2 Boundaries of Jurisdiction

The boundaries of jurisdiction between the RSG and attached piping or structures shall be as defined in Paragraph NB-1130 of subsection NB of ASME Section III.

304.3 Physical Constraints

Should the RSG design require replacement in accordance with 10CFR50.59, all connections and supports shall be designed to provide the same interface points as exist for the present steam generators. If RSG design requires replacement under 10CFR50.90, Seller shall maintain the same interface points for as many connections as possible.

Any interface points recommended by the Seller shall be mutually agreed upon with Purchaser prior to design incorporation.

Each RSG shall be designed to be supported by the existing Steam Generator support system as described in Supplement A and shown in Attachment 5 and applicable Associated Design Information.

304.4 Code and Safety Classification

The Seller shall design each RSG in accordance with the effective edition of ASME Section III. The primary side of each RSG is classified as ASME Code Class 1 and the secondary side of each RSG is classified as ASME Code Class 2. The entire pressure boundary of the component shall be designed and constructed in accordance with ASME III Class 1 requirements. Each RSG in accordance with Regulatory Guide 1.29 is also classified as Seismic Category I. The RSGs shall be inspected by an Authorized Nuclear Inspector (ANI) and a copy of the Code Data Report shall be submitted to the Purchaser. The RSG shall be provided with an ASME Code "N" stamp and shall be assigned a National Board number as required by ASME Section III.

All internals shall be designed and fabricated in accordance with the safety classifications identified in Attachment 6. Seller shall submit a report for Purchaser approval which delineates where the use of commercial grade components and materials is proposed. Subsequent changes to this report shall be submitted to Purchaser for approval prior to manufacturing of affected internals.

304.5 Effective ASME III Code Edition and Addenda

The RSG shall be constructed to the requirements of ASME section III code edition and addenda specified in Section 202.5 Since the original steam generators were constructed to an earlier version of ASME Section III, an evaluation shall be performed by the Seller to address the requirements of IWA-4170(d) of ASME Section XI. This evaluation shall be included in the Design Report.

304.6 Conditions of Service

304.6.1 Environmental Conditions

Each RSG shall be designed for the environmental conditions as defined in Supplement A. RSG design shall be as such to accommodate the EPRI Water Chemistry Guidelines for the primary and secondary sides. The feedwater chemistry program will be based on an "all-volatile treatment" approach. Ammonia, morpholine, monoethanolamine or other organic amines will be added for pH control, while hydrazine or other volatile oxygen scavengers will be used for oxygen control. The Seller shall identify any required changes in environmental conditions for the equipment to perform its design function throughout its design life.

The Seller shall confirm that the tubing material is fully compatible with the water chemistry specification for both primary and secondary sides in the presence of internal geometries, heat fluxes and temperatures selected in the RSG design for the 40 year design life.

The Seller shall confirm that the specified corrosion allowance shall be accounted for in the governing RSG analyses.

The RSG shall be designed for wet and dry (with nitrogen purge) lay up conditions (based on past experience of Purchaser's operations) as well as for six chemical cleanings using the EPRI iron and copper cleaning steps (e.g., the 40-hour, 20% EDTA, 200°F iron step plus a six-hour copper step with 5% EDTA, EDA and hydrogen peroxide). Corrosion allowances shall be provided based on chemical cleaning of the entire tube bundle a total of six times as well as all other operating/shutdown conditions for the life of the RSG.

The type of material used and corrosion allowances for each type of condition (operating/lay up/chemical cleaning) shall be itemized and accounted for in the Design Report for each affected part as well as for each affected weld in the pressure boundary. In addition, the same is required for nonpressure boundary parts and welds including a suitable evaluation to demonstrate adequacy. The evaluation/data for nonpressure boundary parts/welds shall be submitted by the Seller in a separate report for Purchaser approval.

304.6.2 Design Life

The design life of each RSG shall be for a minimum cumulative operating service of forty (40) calendar years. The Seller must insure that no parts or elements of the RSG, not specified for removal and replacement in the RSG Technical Manual, will require to be removed or replaced during the stipulated design life. To insure that the 40 year design life criterion is met, the Seller shall consider all potential failure modes such as corrosion, fatigue, corrosion assisted fatigue, fretting and wear. Cumulative operating service includes periods of wet or dry lay up.

It is understood that the design life as specified herein is in no way to be construed as a warranty or guarantee. Seller and Purchaser expressly agree that the warranties provided by Seller with respect to the RSGs shall be as set forth in the "Warranties" Article of the Replacement Steam Generator Terms and Conditions and nothing in this Section 304.6.2 is intended to alter or modify such warranties.

304.6.3 Moisture Carryover

The moisture separator and steam dryer equipment (including drains) shall be designed and qualified by appropriate tests approved by the Purchaser so that the moisture carryover in the steam shall not exceed 0.10% weight of the steam flow just downstream of SG flow restrictor based on the RSG operating at a steady-state steam flow rate of 4,664,000 lb/hr per RSG (approximately 110% of full power operating conditions) for a steam pressure inside the dryers of 925 psia for all ranges of normal operating water level.

For plant transients during which a turbine trip does not occur, the moisture carryover shall be limited to a maximum of 0.10% weight just downstream of the steam flow restrictors.

The moisture separator and dryer loading with respect to moisture removal rates and steam velocities shall not exceed loading for previous successful applications or suitable tests of such equipment. If this equipment has not operated successfully, e.g., met the moisture content limits, under equivalent loading conditions including flow maldistribution to different separators, the moisture separation and dryer capability shall be demonstrated by testing prior to fabrication of the steam generators. In any event, a report shall be provided by the Seller for Purchaser approval which documents all separator/dryer performance evaluations and tests which are performed.

Carryunder shall be sufficiently limited such that the use of auxiliary feedwater is not required at any power level up to and including a nominal steam flow rate of 4,240,000 lb/hr per RSG. Any carryunder effects upon level control measurement shall be evaluated and documented in a water level control report subject to Purchaser approval.

304.6.4 Thermal and Hydraulic Requirements

Seller shall provide the analysis necessary to address the requirements of this Section (including subsections).

304.6.4.1 General

The largest practical heat transfer surface area is desired consistent with the following constraints (to be applied simultaneously):

1. The shell-side flow areas including the areas inside and outside the wrapper shall be sufficient to provide acceptable steam/water flow velocities with regard to pressure drop, circulation ratio, water level and steam flow stability and flow-induced vibration and wear considerations; and, these flow areas shall contain sufficient secondary side water inventory to provide equal or greater time until dryout occurs following a loss of feedwater.

2. The outer envelope (upper and lower shell diameters, lengths) of the RSG shall be compatible with existing supports, restraints and piping systems per Section 304.9.1 of this specification.

3. The RSGs shall be capable of producing 100% power output operation conditions with 10% of the reactor coolant system flow area through the Steam Generators blocked due to plugging or other repairs as well as with Seller's projected level of fouling over 40 EFPY of operation.

4. The RSG Thermal Design Primary Flow Rate shall be 98,000 gpm for up to 10% plugging. The best estimate primary flow rate for the RSG in the clean condition with no tubes plugged shall be 107,800 gpm, and the mechanical design flow rate shall be 110,000 gpm. (Note that the best estimate flow is not warranted, just an estimate).

5. There shall be no damaging water hammer for all feedwater flow conditions irrespective of water level in the RSG.

6. Equipment will be capable of operating at all specified conditions with freedom from flow-induced or turbulence-induced vibrations which result in tube degradation over the design life of the steam generator.

7. The steam leaving the RSGs will not exceed 0.10% moisture content when operating at 120% nominal steam flow. (Steam generator design point.)

8. Design Replacement Steam Generator performance based on preliminary design information is as follows (assuming fouling factor of .00006 and 100% power):

Design Replacement Steam Generator Performance (Preliminary)			
T_{hot} (°F)	Percent Plugging	RCS Flow (gpm)	Steam Pressure (psia)
616	0	105,900	1028
618	0	105,900	1048
620	0	105,900	1067
622	0	105,900	1088
624	0	105,900	1108
616	10	104,300	1010
618	10	104,300	1030
620	10	104,300	1049
622	10	104,300	1069
624	10	104,300	1089
626	10	104,300	1110

Seller shall consider design basis fouling conditions (based on minimum thermal conductivity of fouling layer) for minimum performance levels.

Each replacement steam generator shall furnish steam at conditions specified in section 304.6.4 and Supplement A of this specification when supplied with reactor coolant and feedwater at the specified conditions.* In addition, 100% power (3821 MWt) steam pressure and flow conditions for each RSG shall be furnished for the T_{hot} range of 616°F to 626°F when supplied with reactor coolant flow and feedwater temperature at the specified conditions.

*Seller shall qualify RSG for operation at 100% power with feedwater temperatures as low as 390°F. Special operating restrictions shall be fully identified by Seller to assure RSG operating life will be 40 years as required by this specification. Thermal performance requirements shall be based on nominal feedwater temperatures.

The Seller shall provide justification for selection of design basis fouling levels over the 40 year design life of the RSG based upon empirical evidence. Justification shall be provided for Purchaser approval with consideration of instrumentation errors as reported by Purchaser to enable demonstration of plant performance during the entire 40 year design life within Seller's stated accuracy.

The RSG shall be compatible with the plant's feedwater control system, steam generator water level measurement and control system, and reactor protection system. Current information on these items for the existing steam generators is summarized in Supplement A.

304.6.4.2 Independent Parameter Analysis

Independent parameter analyses shall be performed and evaluated to cover the following departures from nominal conditions:

(1) Tube plugging - 0, 5, 10, 15, 20, and 25%, and

(2) Tube surface deposit - 0, 2, 5, 10, 15, 20, 25, 30, 35, and 40 mils thickness of 100 percent dense magnetite. Minimum values for thermal conductivity due to magnetite fouling shall be assumed.

Seller shall provide results of analyses for Purchaser approval and identify excess heat transfer area for each condition. Equivalent surface thermal fouling factor (in units of $hr\text{-}ft^2\text{-}°F/Btu$) shall be calculated for each of the surface deposit thicknesses.

304.6.4.3 Reactor Coolant System Flow Analysis

Reactor coolant flow is a function of the combined hydraulic resistance of all components in the loop and by the reactor coolant pump head and flow characteristics. Consequently, the flow cannot be calculated until the hydraulic characteristics of the RSG are known. A correlation between S/G hydraulic pressure losses and RCS loop flow is given in Supplement A. Using this data, the Seller shall determine the best-estimate RCS loop flow that will result when the RSG is installed in a loop with the existing primary system components.

304.6.4.4 Instability Analysis

The Seller shall perform thermal/hydraulic evaluations to determine the effect of increased flow resistance due to deposit buildup at support areas on circulation ratio and water level instability. Margins to instability should be determined and benchmarked based on actual in-plant and/or test experience. The Seller shall demonstrate that the RSG is free of water level and circulation flow instability at all power levels for the following conditions:

(1) 0, 5, 10, and 15, 20 and 25% of tubes plugged and

(2) 0, 10, 20, 30, 40, 50 and 60 mil thick deposit on support and tube surfaces at top support (with thicknesses reduced linearly for other supports down to zero at bottom support).

The shell-side flow areas including the areas inside and outside the wrapper shall be sufficient to provide acceptable steam/water flow velocities with regard to pressure drop, circulation ratio, water level, steam flow stability and flow-induced vibration / tube wear considerations.

304.6.4.5 Subcooling Analysis

The Seller shall demonstrate by analysis or, preferably, by test that the Seller's design has maximized the area of shell side fluid at the surface of the tubesheet that is subcooled under all operating conditions. In this effort, the Seller shall perform analysis to determine the thermal-hydraulic conditions which exist at the surface of the tubesheet of the replacement steam generators. This analysis shall be in sufficient detail to geometrically model the expansion zone at the junction of the tube in the tubesheet and determine the associated thermal-hydraulic conditions. This analysis shall be performed over a range of 0 to 100% power and include local effects of blowdown operation, plugged tubes, and downcomer flow variations (if applicable). The computer codes to be used in this analysis shall be reviewed for acceptability by the Purchaser.

The Seller shall develop a detailed plan to complete the above scope of work. This plan shall be issued to the Purchaser for approval. The scope of work defined in the plan shall be limited to and consistent with the expenditure of 692 engineering hours. Updates shall be presented to the Purchaser periodically during the course of the work to assure concurrence with the approach, assumptions, etc. Upon completion of the work, a report shall be issued to the Purchaser. This report will include the results of the analysis and will also include ideas which might be used to modify the thermal-hydraulic conditions, if required. Any additional work will be mutually agreed upon.

The Seller shall provide analysis or test results that indicate when recirculation begins with respect to reactor thermal power output and demonstrate by test or analysis that periods of nonrecirculation will not adversely affect the tube-to-tubesheet joint integrity. If limitations on nonrecirculating operation need to be imposed, Seller shall fully define them after exhausting all design options to avoid operational procedure changes.

The design of the steam generator shall be such that boiling is minimized at the expansion transition of the tubes and that DNB does not occur in support contact locations or tube to tubesheet crevice. Analysis and or test plans to confirm compliance with this requirement shall be submitted to Purchaser for approval. The analysis shall consider the local effect of blowdown system operation over a range from 0 to 100% power operation and hot leg temperatures specified herein.

The tube support contact area and tube sheet expansion transition area analysis shall address the clean and fouled conditions along with the sensitivity of local adjacent tube plugging effects.

The validation of computer codes against test benchmark data shall be defined in the analysis and or test plan.

The thermal-hydraulic analysis shall, if possible, address the tendency of the downcomer fluid to spiral and its effect on top of tube sheet thermal conditions. As a minimum, the Seller shall provide his opinion (based on the analysis performed above) of the potential effect of downcomer spiraling and its affect on the top of tubesheet thermal conditions.

304.6.4.6 Natural Circulation Analysis

The RSG shall provide the capability for reactor decay heat removal by reactor coolant natural circulation flow which is at least equivalent to that provided by the existing plant steam generators. Thermal/hydraulic evaluations shall be performed which cover various decay heat rates and reactor coolant temperatures and with either main or auxiliary feedwater supplied to the steam generator. All plant inputs needed to perform these evaluations shall be identified by the Seller. Seller shall discuss RSG impact on design transients in the primary and secondary systems.

304.6.4.7 Water Level Control Analysis

The location of the level taps shall be recommended by the Seller and included in the RSG design as mutually agreed with the Purchaser. Analysis documenting the basis for the tap locations and steam generator-specific water level measurement inaccuracies (including, but not limited to downcomer subcooling, velocity effect, density effects and tap location tolerances) shall be presented for Purchaser approval and use in station-specific calculations.

304.6.4.8 Thermal and Hydraulic Analysis Report

NOTE: The Thermal and Hydraulic Analysis Report may include reports or sections of reports required by other sections of this specification.

The Seller shall submit a Thermal and Hydraulic Analysis Report giving the mathematical model, analytical methods used, and the detailed thermal-hydraulic data and performance data. All calculations for the Thermal and Hydraulic Analysis Report shall be based on an assumption that tubes equal to the tube plugging margin are plugged. Heat transfer calculations shall be based on maximum allowable tube wall thickness as specified by Seller per Section 304.9.4.1. The following additional information, as a minimum, shall be provided by the Thermal and Hydraulic Report:

a) Description and drawings of the Steam Generators and various operating characteristics by region of Steam Generators (hot leg, mixing, U-bend, etc.).

b) List of all data, computer codes utilized and other references used to develop thermal and hydraulic characteristics. These include but are not limited to: number of tubes, tube diameter and wall thickness, tube thermal conductivity and heat transfer coefficient, heat transfer area, inlet/outlet nozzle design parameters, tube pitch, tube support size, wrapper size, etc.

c) List of all conditions used to provide a basis for determining the performance of the plant. These include: primary inlet/outlet temperatures, primary flow, feedwater temperature and flow, feedwater temperature vs. load, fouling factors by region, etc.

d) Primary side pressure drops based on thermal and mechanical design flow rates to include: inlet nozzle, tube entrance, tube friction, tube exit, outlet nozzle, etc. For each pressure drop, provide the assumed flow area (ft^2) and form loss coefficient (K loss). Pressure drops should be given in 'psi'.

e) Secondary side pressure drop vs. flow for various regions and areas including but not limited to: all components of the feedwater distribution equipment (feedring, flow restrictor, diffuser, etc.), across each and all tube support plates, U-bend region, plenum transition, primary separators, separator transition, secondary separator, steam flow restrictor, etc. Pressure drops shall be evaluated over the full range of fouling. For each pressure drop, provide the assumed flow area (ft^2) and form loss coefficient (K loss). Pressure drops should be given in 'psi'.

f) Static head required to maintain normal water level over the full range of fouling.

g) For fouling layer thickness of 0 to 40 mils in increments of 5 mils:

Graphs showing steam pressure vs. heat load,
Graphs showing steam pressure vs. tubes plugged,
Graphs showing steam pressure vs. hot leg temperature.

h) Graph showing circulation ratio vs. heat load over the full range of fouling.

i) Graphs showing shrink and swell, starting at 10% heat load at a rate of ±5% load changes, plus graphs for a turbine trip as a function of power level.

j) Graphs showing overall heat transfer coefficient vs. heat load by Steam Generator region (hot leg, U-bend, coldleg, mixing, etc.) for fouling layer thickness of 0 to 40 mils in increments of 5 mils. Graphs of overall heat transfer coefficient vs. percentage of tubes plugged.

k) Graphs showing hydraulic design including circulation loop driving head vs. heat load and circulation loop pressure drop vs. location at full load (by location within Steam Generator - wrapper opening, support plates, top of tube bundle, top of wrapper, top of primary separator, etc.) Pressure drops shall be evaluated over the full range of fouling. For each pressure drop, provide the assumed flow area (ft^3) and form loss coefficient (K loss). Pressure drops should be given in 'psi'.

l) Graphs showing secondary side mass/water volume vs. heat load. (Total mass and water/steam content). Graphs showing secondary side mass/water volume as a function of elevation for cold shutdown conditions. Graphs of narrow range and wide range water level versus total and partial secondary side water volume (at full load).

m) Data detailing cross sectional flow areas by location within Steam Generator - tube bundle width, feedring, normal water level through primary separators, downcomer, etc.

n) Secondary side volumes by location - feedring, downcomer below normal water level, downcomer above normal water level, backing region, mixing region, primary separator region, secondary separator region, etc. This shall include a graph with volumes starting from tube sheet up to top of steam nozzle. Provide a schematic that identifies the region being defined as a volume.

o) Primary side volumes including nozzles, channel head hot/cold leg, total tube volume, etc. This shall include a graph with volumes starting from bottom of channel head up to top of U-bend.

p) Surface area exposed to primary fluid by class of material/stainless, Inconel, etc.

q) Graphs showing allowable water level variations vs. heat load (upper and lower level variation).

r) Graphs showing blowdown flow rates vs. heat load, including quality at nozzle outlet. Additionally maximum continuous blowdown flow rates and absolute maximum (per 304.9.10) shall be analyzed for erosion concerns.

s) Technical support and data for site specific input to revise the plant simulator model.

t) Graph showing percentage of tubes plugged versus T_{hot}.

u) Graphs showing fouling rate (mils) vs. EFPY of operation for each distinct section of the tube bundle. Surface of the tubesheet shall also be included in this evaluation.

v) Graphs showing RCS flow (lbm/hr) vs. percentage (%) of tubes plugged.

w) Graph or table of exit quality (%) for each distinct section of the bundle identified as a function of load.

x) Graph or table of percent carryover and percent carryunder by mass vs. inlet quality, flow and operating water level (inches from base of riser) for primary and secondary separators.

y) Graph or table of change in separator efficiency vs. time of operation and identification of the erosion rates assumed.

z) Velocity profiles through the tube bundle and evaluation of design features to limit sludge deposition. Analysis of the efficiency of contaminant removal by the blowdown system should be provided as a function of power level.

All graphs shall be accompanied by corresponding data tables. Seller shall identify all pertinent load dependent parameters used to generate the requested secondary side parameters as a function of load.

Any additional inputs required from Purchaser to perform performance calculations which are not contained in this specification shall be identified by the Seller.

304.7 Design Features and Improvements

While compatibility of Replacement Steam Generator's operating characteristics with existing plant equipment and operation is required, the Purchaser also requires that the new equipment incorporate, as much as possible, the design innovations made in Steam Generators subsequent to the manufacture of the original equipment. These innovations are expected to improve reliability, maintainability and performance and extend service life.

More detailed information concerning tests, analyses and experience which serve as the basis to demonstrate the adequacy of design improvements in all respects shall be documented by the Seller in a Reliability Report submitted for Purchaser approval. As a minimum, the effect of design improvements shall be evaluated with respect to:

- Water level/steam flow stability
- Circulation ratio
- Two-phase pressure drop and primary system pressure drop
- Carryover and carryunder
- Primary and secondary water/energy inventory
- Hot leg temperature
- Plugging allowance
- Maintenance
- ALARA design features

304.8 Design Loading Requirements

304.8.1 General

The design and structural analysis of each RSG shall be consistent with the requirements of this specification, applicable regulatory guides and the ASME Section III code edition prescribed in section 202.5 of this specification. The Seller, acting as the Purchaser's (Owner's) designee shall prepare a Certified Design Specification (CDS) pursuant to the requirements of Paragraph NCA-3250 and Appendix B of ASME Section III for Purchaser's (Owner's) approval. The CDS shall provide all design inputs required for the design and fabrication of each RSG including, but not limited to, the following:

- Stiffness values of the primary, main and auxiliary feedwater, and main steam nozzles.
- Pressure, temperature and flow transients for the RCS as described in 304.8.3.
- Maximum permissible divider plate differential pressures for the RSG divider plate for emergency and faulted conditions. Number of cycles of these transients are given by Supplement A. A limiting break size shall be specified which corresponds to the differential pressure calculated for emergency conditions.

In the event that the structural characteristics of the RSG (stiffness and mass) are not identical to those of the original SG, the Seller shall provide a structural analysis of the reactor coolant system which includes the RSG that demonstrates compliance with all requirements of the UFSAR and the appropriate edition of the ASME Code. The analysis shall address all loading conditions defined in the Certified Design Specification. All regulatory requirements/commitments in the plant Safety Evaluation Report (SER) must be satisfied by said analysis.

Seller shall consider Purchaser's option to replace upper lateral support snubbers with rigid struts. as soon as practical after contract award, Seller shall submit a proposal to identify the added cost of analysis resulting from a decision to replace the snubbers, if any, and specify a deadline for Purchaser to make the decision.

304.8.1.1 Structural Load Sources/Load Combinations

Sources of loading to be considered in structural analysis of the RSG (pressure boundary and internals) are as follows:

304.8.1.1.1 Deadweight

304.8.1.1.2 Primary system pressure

304.8.1.1.3 Secondary system pressure

304.8.1.1.4 Pipe nozzle loadings

If the RSG design requires replacement under 10CFR50.90, all deadweight and seismic nozzle loads specified in section B9 of Supplement A shall be increased by 20% for RSG structural analysis.

304.8.1.1.5 Pipe rupture loadings

304.8.1.1.6 Seismic inertia and anchor movements

304.8.1.1.6.1 Operating Basis Earthquake (OBE)

The RSG shall be operable during and after an OBE. The horizontal (two components) and vertical component loadings for OBE shall be taken from Associated Design Information Package 1. Modal and directional combinations shall be performed in accordance with Regulatory Guide 1.92.

304.8.1.1.6.2 Safe Shutdown Earthquake (SSE)

The horizontal (two components) and vertical component loadings for SSE shall be taken from Associated Design Information Package 1. Modal and directional combinations shall be performed in accordance with Regulatory Guide 1.92.

304.8.1.1.6.3 Seismic Anchor Movements

Seismic anchor movements shall be considered as design inputs if required by the methodology used to model the RSG for structural analysis.

304.8.1.1.7 Flow Loads

Flow loads are considered to be particularly important for tubes and internal structures. Flow loads shall be calculated by the Seller based on the pressure, temperature and flow information provided in this specification.

304.8.1.1.8 Thermal Loads

Thermal loads and transients produced by primary, steam and feedwater temperatures.

304.8.1.2 Load Combinations

The load combinations for structural evaluation of the RSG (pressure boundary) shall be consistent with the load combinations that are used in the original steam generator design specification. Leak before break (LBB) has been approved for STP reactor coolant loop (RCL), pressurizer surge line, and the accumulator discharge lines. The dynamic effects due to postulated pipe break in the LBB approved lines may be excluded from the structural evaluation of the RSG.

304.8.2 Design Conditions

The following design conditions shall be used for thermal, hydraulic and structural analyses in accordance with Section III, Div. 1 of the ASME Boiler and Pressure Vessel Code as well as for vibration evaluations.

304.8.2.1 Primary System Components

(1) Pressure: 2485 psig

(2) Temperature: 650°F

(3) Flow: Mechanical Design Flow (TBD)

304.8.2.2 Secondary System Components

(1) Pressure: 1285 psig

(2) Temperature: 600°F

(3) Steam and Feed Flow: 5,512,000 lb/hr per RSG (30% margin).

304.8.2.3 Primary-Secondary Boundary Components

(1) Maximum primary to secondary pressure difference for normal operating conditions described in 304.8.3

(2) Maximum secondary to primary difference for normal operating conditions described in 304.8.3

(3) Temperature for normal operating transients below.

304.8.3 Operating Conditions

The following operating conditions shall be used for thermal, hydraulic and structural analyses in accordance with Section III, Div. 1 of the ASME Boiler and Pressure Vessel Code as well as for vibration evaluations required by this specification. Seller shall generate all transient response curves once the RSG design is final. These curves shall be submitted to Purchaser for inclusion into the Replacement Steam Generator Certified Design Specification. The original equipment specification gives the transient responses for the existing steam generators. If any of the original transient loadings are exceeded, the Seller shall be responsible for any reanalysis of the affected piping, restraints and supports.

304.8.3.1 Normal Operating Transient Conditions (Service Level A Transients)

Normal transient loads are those to which the RSG is exposed in the performance of its specified service function. These loads occur during plant start-up, operation in the design power range (including loading and unloading), hot standby and system shutdown.

304.8.3.2 Upset Conditions (Service Level B Transients)

Upset transient loads are those to which the RSG is occasionally exposed during plant transients. Those loads occur during plant trips or as a result of equipment/system trips or malfunctions.

304.8.3.3 Emergency Conditions (Service Level C Transients)

Emergency condition loads are those to which the RSG could be exposed during infrequent plant transients such as a small steam line break or a complete loss of reactor coolant flow.

304.8.3.4 Faulted Conditions (Service Level D Transients)

Faulted condition loads are those to which RSG is not normally exposed, but may be exposed to under extreme or unusual conditions. Pipe break scenarios or major equipment malfunctions are examples of such conditions.

304.8.3.5 Test Conditions

Test conditions are those pressure tests (including hydrostatic tests, pneumatic tests and leak tests) specified by Purchaser and/or required by Section III of the ASME Boiler and Pressure Vessel Code. Conditions for pressure tests which will be conducted after installation shall assume maximum pressure on primary side per 304.8.2.1 with secondary side vented and maximum pressure on secondary side per 304.8.2.2 with primary side vented. These tests will be conducted in accordance with Section XI of the ASME Boiler and Pressure Vessel Code. The Seller shall identify the number and type of shop tests to be performed and consider the shop test conditions in the structural design of the RSG. The shop and in-plant test conditions shall be evaluated in the Design Report.

304.8.4 Fabrication, Shipping and Installation

The Seller shall determine the loads applied to the RSG during fabrication, loading, shipping, unloading, placing into storage and installation, and shall consider these loads in the structural evaluation of the RSG (pressure boundary and internals).

304.8.5 Fatigue Analysis

The Seller shall perform fatigue analyses of the RSG (pressure boundary and internals) as required by Section III of the ASME Boiler and Pressure Vessel Code. The fatigue analysis shall be documented in the Design Report. The fatigue analyses shall demonstrate that the RSG is capable of withstanding the accumulated load cycles imposed by the combinations of conditions required by this specification. Test loading cycles shall be included in the fatigue analysis. The analysis shall include identification of the most significant fatigue locations and an evaluation of the potential impact of fabrication tolerances on fatigue.

304.8.6 Dynamic Qualification

Equipment adequacy for all dynamic loading conditions shall be demonstrated for pressure boundary and nonpressure boundary components. The dynamic analysis of the RSG and its supports (lateral and vertical) shall be performed by the Seller and the results shall be transmitted to the Purchaser for impact assessment on the building structure.

Dynamic loading analysis of internals in the Replacement Steam Generators shall be limited to Replacement Steam Generator internals whose failure to remain intact during Service Level A, B, C and D transients could jeopardize the integrity of the primary, secondary and the primary-to-secondary pressure boundary. Equipment adequacy shall be established for both the OBE and SSE.

The following elements shall be included in the analytical method:

a) The critical areas of the equipment shall be defined. The basis for determining criticality shall be stated in detail by the Seller.

b) The significance of various equipment components shall be examined.

c) A tractable model with necessary assumptions shall be defined.

d) The characteristics of supports, attachments, and piping shall be in accordance with the existing plant.

e) The properties of connecting members between masses necessary to approximate to the structural stiffness of the system shall be defined.

f) The extent to which the proposed mass breakdown permits determination of stresses and deflection in significant or critical areas shall be defined.

g) The decision to include an element of the equipment as a separate mass point may depend on the natural frequency of the element. Estimates of the natural frequencies of the elements which are large enough to affect the response of the system shall be determined prior to lumping the element stiffness and mass.

Response spectra modal analyses shall be initiated by calculating natural frequencies (eigenvalues), mode shapes (eigenvectors), and participation factors. The input response spectra pertinent to the equipment mounting location and damping level shall be used as input to calculate the modal accelerations at each mass point in the model.

g1) Enough modes shall be extracted so that the highest frequency included in the modal combination rule just exceeds the frequency at which the spatial acceleration becomes approximately equal to the peak acceleration (ZPA value). The absolute double sum rule for modal combination shall be used to consider the effect of extracted modes.

g2) The static effect of higher frequency modes not included under item g1, above shall be appropriately included in the analysis using available procedures; (for example, see Appendix A of Standard Review Plan (SRP) 3.7.2.).

g3) The responses from items g1 and g2, above are combined using square root of the sum of the squares (SRSS) method to determine the maximum response for the seismic direction being considered.

g4) The modal inertia forces shall be obtained by multiplying the lumped masses of the model by the modal accelerations, eigenvectors, and participation factors.

g5) Inertia forces shall be applied statically to the model on a mode-by-mode basis while retaining the vector directionality and the resultant modal internal loads.

For the input response spectra provided, the system shall be evaluated for the simultaneous occurrence of horizontal and vertical motions. Components of stress, strain, moment, shear, or displacement may be evaluated in determining the maximum response of the system or equipment.

Dynamic systems that exhibit closely spaced modes (two consecutive modes are defined as closely spaced if their frequencies differ from each other by 10 percent or less of the lower frequency) shall be analyzed in accordance with R.G. 1.92.

Dynamic analysis may also be nonlinear time history analysis solved by direct integration. In this case, the Seller shall generate time versus acceleration records for the applicable earthquakes and directions based upon the amplified response spectra provided.

Unless specifically noted, the equipment shall be analyzed in a worst-case basis with regard to the specified operating conditions. A check of critical area deflections shall be made to demonstrate that damage detrimental to the equipment's ability to function as specified will not occur.

Each Replacement Steam Generator shall be designed to withstand the effects of cyclic loads due to reactor coolant system temperature and pressure fluctuations (normal power anomalies).

304.8.7 Seismic Environment

The Seller shall submit a summary of the Seismic Qualification Program. This summary shall include a description of the mathematical model and the analytical methods used to qualify the Replacement Steam Generators.

The Seller shall confirm, in writing, and shall submit calculations or test data or both for approval by the Purchaser which support the statement that equipment furnished under this specification meets the requirements for the Operating Basis Earthquake and Design Basis Earthquake (SSE). A necessary condition to justify utilizing this specification requires that the Seller shall, as part of its report, provide natural frequency data, determined by either analysis or test. The analysis or test shall confirm that the resulting deflections will not cause damage to the equipment to the detriment of its capability to function as specified elsewhere.

The equipment shall be operable during and after an OBE earthquake.

304.8.7.1 Operating Basis Earthquake

The equipment shall be designed to be capable of continued operation with all normal operating loads acting simultaneously with both horizontal and vertical components of the Operating Basis seismic loadings. The horizontal and vertical seismic loadings for the existing support locations are as shown in the Associated Design Information.

304.8.7.2 Design Basis Earthquake

The equipment shall be designed to withstand the combined effects of all normal operating loads acting simultaneously with the Design Basis seismic loads without loss of safe shutdown capability or structural integrity. The horizontal and vertical seismic loadings for the existing support locations are shown in the Associated Design Information.

304.8.7.3 Seismic Modal Response and Spatial Components Combinations

Seismic modal responses and spatial components shall be made in accordance with NRC Regulatory Guide 1.92.

304.8.8 Design Report

The Seller shall submit for Purchaser approval a complete Design Report including all calculations and all references not in the public domain in accordance with the requirements of ASME Code Section III. The report shall be certified by a Registered Professional Engineer qualified in accordance with ANSI/ASME N626.3. The report shall discuss all loads and load combinations, including but not limited to, vibration, static, nozzle, seismic, cyclic, thermal, hydraulic, pressure, weight, impact and loads and load combinations resulting from all steady-state and transient operating conditions specified and confirm the adequacy of the equipment design, in accordance with ASME Code Section III and any other applicable requirements.

Seller shall obtain independent review (as required by design control provisions of NQA-1/ANSI N45.2.11) of the stress analysis by independent organization within Seller's company or an identified and mutually agreed upon second party.

The supporting analysis/reports for the Design Report including any references and test data shall be submitted for Purchaser's approval and shall include, but shall not be limited to, the following:

1. Thermal-Hydraulic Analysis Report including all basic RSG sizing calculations and performance analysis results at various loads. Items reported shall include, but not be limited to reactor coolant temperatures, heat transfer coefficients, circulation ratios, fouling factors, and tube and shell side pressure drops.

2. Flow-Induced Vibration Report on the tube bundle and internals (including tubes and all types of supports) with analyses and supporting test results.

3. Secondary Pipe Break Analysis Report which assesses steam generator internals adequacy for steam and feedwater pipe break conditions including simultaneous breaks of both of these pipes.

4. Primary Pipe Break Analysis Report which assesses the adequacy of the tubes and divider plate for primary pipe break conditions.

5. Seismic Analysis Report which assesses the adequacy of the RSG for seismic loads.

6. Tube and Tube Material Report which assess adequacy for corrosion, wear and RSG internal environmental conditions.

7. Tube, Tube Support and Tubesheet Deflection Analysis which addresses deflections during heatup, cooldown, and operation of the unit.

Conformance with ASME III requirements shall be demonstrated in the Design Report. Each Replacement Steam Generator shall be designed to impose loads which do not exceed the design capability of the existing plant equipment and structures, including the support structure, reactor coolant system piping, feedwater and steam piping, and all other physical interfaces.

Each Replacement Steam Generator and all its parts shall be designed to preclude corrosion damage or malfunction as a result of vibration, including flow-induced and turbulence-induced vibration during normal or off-normal operation and environmentally induced vibration. The Design Report shall identify the corrosion and wear allowance on all Replacement Steam Generator(s) internal components and pressure boundary materials.

The Seller shall identify in the Design Report other relevant incidents, if any, in addition to the previously listed categories, and shall analyze them in accordance with ASME Section III code.

Seller shall furnish pressure-temperature curves (heatup/cooldown) and analytical bases for the Replacement Steam Generator as part of the design report.

304.9 Mechanical Requirements

304.9.1 Vessel Design

In order to facilitate installation of the RSGs and minimize the impact of reconnection of interfacing piping and support systems, the outer shell of the RSGs shall duplicate the outer envelope of the existing steam generators to the maximum extent practical, and within practical shop tolerances. Purchaser's installation contractor (or representative) shall be afforded with necessary access to Seller's shop for the purpose of verification of vessel shell and feature (i.e., nozzles and access ports) interface dimensions and location/orientation identified by the Purchaser as critical. Such access shall be provided prior to RSG shipment and at a point in the fabrication process in which adverse impact to RSG delivery schedule is minimized by identification and correction of out of tolerance conditions. Changes in Steam Generator design which affect the outer shell envelope shall be approved by Purchaser, and are subject to the following constraints:

1. The heat exchanger outer envelope (shell outer diameter plus maximum nozzle protrusion) may not exceed the envelope such that there is no longer adequate clearance through the equipment hatch. (The Equipment Hatch cross sectional area available is shown in Item B7 of Supplement A, Part B.)

2. The primary nozzles and support pad interface points must be duplicates of those on the existing steam generators.

3. The upper lateral support restraint connections at the enclosure wall shall be maintained. Seller shall provide redesigned upper lateral support restraints and snubbers (if necessary) as accessories to the RSGs.

The weight of the RSG shall not exceed 894 tons in the flooded condition to accommodate (estimated) existing support limits. The dry weight of the RSG shall not exceed 500 tons to accommodate (estimated) limits of the lifting equipment in containment. Should RSG weight exceed these specifications, economic benefits shall be quantified by the Seller to allow Purchaser to perform a cost-benefit analysis.

Each RSG channel head, upper (steam drum) head, tubesheet, and transition cone shall be of single piece forged construction. The transition cone shall be furnished with cylindrical sections (standoffs) on both ends which allow girth welds to attach the steam drum and lower heat exchanger shells. The purpose of the standoffs is to remove the girth weld from a transition location local stress concentrations and consequently relieve the Purchaser of ISI requirements. Therefore, the welds connecting the transition cone to the steam drum and lower heat exchanger shall not qualify as gross structural discontinuities or sites of stress concentrations. Cylindrical steam drum and lower heat exchanger shell sections may be of forged or rolled and welded plate construction.

All blend radii between nozzle bores and the inside of the shell or head shall be greater than 0.5 inches unless identified and justified by the Seller and approved by the Purchaser.

The design, material and length (2 inch minimum) of all nozzle safe ends shall be in accordance with this specification.

All welds on the surfaces of the shell and heads, including nozzle attachments, shall be ground to remove discontinuities and stress risers and to facilitate examinations and inspections. All welding (including cladding) and grinding shall be performed before any required post-weld heat treatment unless approved by the Purchaser.

Except for surfaces of corrosion resistant material, all surfaces to be contacted by primary system water and all gasket contact surfaces (including those on the secondary side) shall be weld deposit clad.

Except for the possible crevice between a tube and its hole in the tubesheet and at the channel head bowl drain, all primary and secondary wetted pressure boundary surfaces shall contain no crevices or abrupt changes in contour sharper than 1/8" radius.

304.9.2 Channel Head

The channel head shall be welded to the tubesheet. The divider plate shall be sealed to the channel head and to the tubesheet by welding. The primary system nozzles shall have forged stainless steel SA-336 Type F316LN material safe ends with sufficient length for field fitup. The fabrication sequence must be such as to preclude PWHT of the head subsequent to safe end attachment. The design, material and length of these safe ends shall be submitted by the Seller for Purchaser approval. Reference blocks shall be provided 90° apart around the nozzle circumference for use in field machining and in determining final dimensions. Primary nozzles shall be fitted with nozzle dam rings compatible with nozzle dams as specified by the Purchaser. (Latest 'quick-fit' slotted design as opposed to single orientation 'bayonet' design)

The design and configuration of the channel head assembly shall allow equivalent or improved access to the tube bundle for NDE, tube sleeving, stabilizing and plugging, as compared to the existing steam generator. The design shall provide for complete draining (including manways) into the primary system. If internal drains from one area to another (to avoid trapping of water) are utilized, they shall be a minimum of 0.5 in. inside diameter, (to avoid plugging with debris) shall be of corrosion resistant material and shall have a smooth inside bore surface (to facilitate sealing of plugs.) External drains are prohibited.

The channel head shall be clad per this specification. All clad and divider plate surfaces exposed to water shall be smoothed by mechanical polishing followed by electropolishing. Electropolishing treatment shall prevent intergranular attack or pitting and shall be submitted to the Purchaser for review and approval prior to start of work. Any electrode arcing on the surface or surface discoloration shall also be removed by the polishing. Work shall conform to the guidelines, parameters and procedures developed under EPRI Research Project 2758-6, see EPRI NP-6617, "Electropolishing Qualification Program for PWR Steam Generator Channel Heads" and EPRI-NP-6618, "Electropolishing Qualification Program for PWR Steam Generator Divider Plates."

Channel head support pads shall be properly machined to accommodate and facilitate Purchaser's installation of the RSG with existing interface support systems. The Seller shall specify and hold the tightest achievable flatness and in-plane parallel tolerances across the pads. Support pad bolt and pattern dimensions shall be verified and documented by the Seller in the as built condition to ensure proper fitup with Purchaser's in plant supports. Helicoil or other off-design condition repair of the support pads is prohibited, however, the Seller shall provide qualification of helicoils for subsequent in-service repair.

304.9.3 Tubesheet

Dimensions and tolerances for the tubesheet holes shall be selected by the Seller to provide suitable clearances for tube bundle assembly and sludge lancing and operations and acceptable residual tube stresses and cold work following the hydraulic or explosive expansion of the tubes in the tubesheet. However, the Purchaser specifically requires that tube hole run out (drill drift) be maintained below a maximum 0.010 inches per foot. Surface roughness requirements within tubesheet holes shall be consistent with normal practice which has resulted in satisfactory performance with regard to sealing of the crevice and prevention of corrosion of the tube. All relevant dimensions and tolerances (including but not limited to tube pitch, hole location, hole angularity, hole diameter, hole surface roughness and tubesheet thickness and face parallel) shall be submitted by the Seller for Purchaser approval. This submittal shall contain sufficient information to demonstrate adequacy based on past successful experience, tests and analyses as well as sufficient detail to demonstrate the applicability of the related tests and experience.

Seller shall specify the method to control tubesheet flatness and parallelism to ensure that tube to tubesheet crevice depth is less than the stated maximum or that the tubes are not expanded beyond the top of the tubesheet.

If the tubesheet is welded to the channel head after tube sheet holes are drilled or tubes are installed, the Seller shall ensure that post weld heat treatment of the channel head-tube sheet weld does not impact the tube-to-tube sheet joints. Justification of this shall be provided to Purchaser.

Prior to drilling, the cladding on the primary side flat face of the tubesheet shall be Ultrasonically Tested (UT) to ensure proper fusion of the cladding to the sheet material as well as to identify indications. Procedures to determine fusion and indications and acceptance criteria shall be developed by the Seller and reviewed and approved by the Purchaser. Process control requirements shall be listed to control drill parameters/ tolerances during drilling of the tubesheet. After drilling, holes shall be measured to confirm compliance with required dimensional tolerances. Compliance may be demonstrated via use of statistical process management (SPM) in lieu of 100% inspection provided that the Seller's SPM methodology is submitted for Purchaser approval prior to use.

The shell side of the Replacement Steam Generators shall be capable of being completely drained.

Tubesheet thickness and material selection shall optimize reduction of tubesheet deflection and necessary tube to tubesheet contact pressure.

Maximum tubesheet thickness is preferred in order to minimize tubesheet deflections which in turn are to minimize tube deflections/stresses and any tendency to cause mechanical interference type plugs to loosen.

The channel-head side of the tubesheet of each RSG shall be permanently marked by the Seller in order that tubes can be easily identified from the channel head to facilitate in service inspections. The tubesheet shall be marked in accordance with tubesheet layout drawings to be supplied by the Seller. The method of marking shall be permanent and readable from a manway location with minimum need for optical instruments or other accessories and shall be subject to Purchaser approval.

304.9.4 Tubing

304.9.4.1 Tube Design

Tube dimensions shall be determined by the Seller in order to optimize thermal performance and corrosion resistance and support safety analyses. In addition, the Seller shall consider the facilitation of post installation secondary side inspection and sludge removal.

Tube wall thickness shall be based on the conditions specified herein and shall be selected with consideration of design pressure, hydrotest pressures, and other relevant conditions*. Tube wall thickness shall also be in compliance with R.G. 1.121 (DRAFT). Compliance of the design with R.G. 1.121 shall be explicitly stated by the Seller in the Design Report. In addition, suitable allowance in the selected tube wall thickness shall be provided for tube wear and corrosion over the life of the RSG. The thickness of the tube wall in the bend area after bending shall not be less than the design minimum required thickness. Tube dimensional tolerances shall be specified so as to comply with all requirements of this specification. Sufficient dimensions shall be measured on a statistical basis, approved by Purchaser, and documented in the Reliability Report so as to determine the as-built nominal, maximum and minimum dimensions for tube O.D., I.D. and wall thickness in straight sections as well as in "U" bend areas.

* Tubing stress analysis shall properly document and account for corrosion allowance on both primary and secondary sides. The corrosion allowance must consider general and local corrosion processes to ensure mechanical integrity of tubes over the entire 40 year design life of the RSGs. The design basis ID velocity shall be justified to ensure freedom of flow assisted corrosion/erosion of tubing material at the design basis temperatures and pressures.

Seller shall ensure that the replacement steam generators are less resistant to flow than the original steam generators, so that primary system flow is increased. Seller shall ensure that the increase in primary system flow does not exceed the station's mechanical design flow limit, OR Seller shall increase the mechanical design flow limit as required to envelope the expected and desired increase in RCS flow. The amount of increase in flow, and any proposed increase in Mechanical Design Flow shall be coordinated to ensure the potential impact on nuclear fuel and BMI thimble wear is addressed, and the design basis is revised as required. Promptly after award, Seller shall coordinate with Purchaser to determine the appropriate operating point for the plant (i.e., T_{hot}, Main Steam pressure, RCS flow, etc.) after steam generator replacement.

Tube centerline bend radius shall be at least 4.7 times the tube O.D. for "U" bend tubes.

304.9.4.2 Tube Fabrication

Seller shall describe, in detail, the program implemented to qualify prospective tubing suppliers. The inspections and standards for successful pre-production qualification shall be included. The standards shall include microstructure gallery and finished ID and OD cleanliness standards.

Seller shall provide descriptions of experience with tubing suppliers and provide a justification for the recommended supplier (including production capacity applicable to support the submitted RSG fabrication schedule and status as an approved supplier).

Seller shall obtain proposals from tubing vendors for Seller's standard tubing specification with the additional requirements of this Specification. All tubing vendors which meet these requirements shall be considered qualified. If Purchaser dictates a specific supplier to be used, the difference in schedule and cost impact from the lowest qualified supplier shall be to Purchaser's account.

The Seller retains the responsibility for satisfying the submittal requirements stated above after Contract award. In addition, the following specific requirements apply to tube fabrication.

Periodically, the metal temperatures of a sufficient number of tubes shall be determined during mill anneal so that the location of the hottest and coldest tubes can be determined.

The metal temperatures of the hottest and coldest tubes shall be recorded during mill anneal operations.

The specified temperature determination shall be performed at least once per heat treatment lot. In addition, the furnace temperature shall be continuously recorded at several locations. On a continuous basis, and prior to start of work on a tubing order, temperatures shall be recorded along the length of the hottest and coldest tubes, (i.e. at tube ends and at four intermediate locations along the tube length.) The hottest and coldest tube locations shall have been identified by tests of the specific furnace used.

Grain size shall be determined for each lot of tubing and shall be between or equal to ASTM 6 and 8, per ASTM E 112.

With regard to surface imperfections, no imperfection or combination of imperfections with an aggregate dimension in the direction normal to the wall in excess of 5% of the wall thickness shall be permitted.

Any discoloration in excess of acceptable visual standards approved by the Purchaser shall be cause for rejection.

During any heat treatment, the tubing shall not be contacted by any combustible products (except hydrogen) unless approved by the Purchaser.

All non-destructive tests shall be reviewed/approved by the Seller as well as by the Purchaser. Prior approvals by the Seller shall not be considered sufficient.

The tubing manufacturer shall be required to evaluate the axial variations in tube tensile properties on three tubes straightened after tube straightener equipment set-up and on one tube after each in-process adjustment of straightening parameters. The locations of maximum and minimum hardness shall be determined by an axial hardness scan on each tube so evaluated. Tensile tests shall be performed from tubing samples removed at the maximum and minimum hardness location and the 0.2% offset yield strength shall be demonstrated to lie in the range of 40 to 55 ksi (after thermal treatment).

No grit blasting or local manual straightness corrections are permitted after final thermal treatment. Local surface imperfection removal after final thermal treatment shall be controlled and limited to hand polishing using Scotch Bright.

No rework of the "U" bent tubes is allowed such as to achieve ovality, buckling and transition minimum radius of curvature requirements.

Each tube shall be ECT inspected using a standard differential coil probe prior to assembly into a tube bundle (details to be furnished by Purchaser per existing site practices and equipment). Purchaser approval is required for the establishment of the acceptance/rejection criteria of tubes displaying ECT signal anomalies.

Unless waived by the Purchaser (based on existing test data submitted by the Seller, which is valid for operating T_{hot} of 626 degrees F), tube sections representative of all "U" bend areas (transitions and mid-sections), including the shortest and longest radius bends, shall be tested for tendency for increased corrosion cracking. These tests shall utilize corrosive media and will compare any tendency for significant cracking (up to 40 percent through wall) of the tube areas in question versus straight sections of tubing for the same test conditions used in similar tests for tube/tubesheet joints. Seller shall recommend the test procedure and acceptance criteria for Purchaser approval. Any substantial increase in cracking tendency for "U" bend areas (versus straight sections of tube) shall be possible cause for rejection of the design by the Purchaser.

The minimum radius of curvature (in a plane parallel to the tube axis) at either the inside or outside surface of the tube shall be two inches anywhere within the transition area between the straight and bent sections of the tube or in areas of buckling.

Tube sections representative of "U" bend areas and expansion transitions within the tubesheet which have undergone maximum tensile strain shall be appropriately sectioned and examined (ID and OD) with a microscope at sufficient magnification for any evidence of micro cracking opened up due to strain. No micro cracking shall be permitted. Seller shall recommend the test procedure and acceptance criteria for Purchaser approval.

Tube ovality shall be tightly controlled during the bending operation. Based on the specific bending radius, the following quality shall be achieved:

For $R \geq 15$ * tube O.D., Ovality $\leq 1.6\%$
For $15 < R \leq 8$ * tube O.D., Ovality $\leq 2.6\%$
For $4.9 \leq R < 8$ * tube O.D., Ovality $\leq 2.8\%$

Where R = bending radius

Tubes with a minimum 12 inch centerline bend radius shall be thermally treated after "U" bending for a minimum of two hours.

Tubing signal to noise ratio shall be 15:1 or greater as determined by Purchaser approved procedure.

304.9.5 Tube-to-Tubesheet Joint

Tubes shall be welded to the tubesheet and subsequently expanded for essentially the entire depth of the tubesheet and clad.

In general, the Seller shall provide a joint design which optimizes joint integrity and corrosion resistance. Specifically, the joint shall be designed and fabricated to adequately satisfy the following requirements:

1. The seal weld alone (with the joint in the unexpanded condition) shall be proven to leak tight through helium leak test or other means subject to Purchaser approval.

2. Weld rollover or shrinkage shall not interfere with standard plug or sleeve installation or restrict the installation of a standard ECT probe. Note that repairs to correct excessive weld rollover shall be per Purchaser approved procedures.

3. Tubesheet hole size shall be optimized and controlled to minimize residual stresses/strain in expanded tubes and tubesheet ligaments and achieve optimum margin with respect to tube pullout requirements.

4. Residual O.D. tensile stresses in expanded tubes shall not exceed 50% of the material yield strength (at ambient temperature and prior to any cold work) as measured by x-ray diffraction. Application of this requirement is subject to the following: Seller and Purchaser shall evaluate the suitability of x-ray diffraction to measure O.D. tensile stresses against this acceptance criterion, and if the x-ray process is technically acceptable, Seller will perform.

5. Crevice depth (between the tube and the top of the tubesheet shall be minimized. However, expansion of the tube, in-situ, above the top of the tubesheet is prohibited.

6. The joint shall not permit the ingress of secondary fluid (weepage) below the crevice subject to the conditions imposed by operation of the RSG at power.

7. It shall be proven that the structural integrity or corrosion resistance of the joint is not adversely impacted if the associated tube were to become locked in a tube support.

8. Mockups fully representative of materials and fabrication processes related to the joint shall be corrosion tested to ensure that the proposed configurations and fabrication techniques are acceptable regarding any tendency for corrosion cracking, excessive porosity or cracking at the mechanical transitions and welds. These tests shall utilize corrosive media and will compare any tendency for cracking in the joint area versus straight and "U"-bend tube areas. The corrosion test method shall permit a valid comparison of results with historical test data and various joint configurations. The Seller shall recommend the test procedure and acceptance for Purchaser approval.

The Seller shall submit, for Purchaser approval, a procedural description of a joint qualification program which provides empirical evidence (through testing on mockups which for practical purposes duplicates and envelopes worst

case configuration and fabrication tolerances and service conditions of the RSG) that the proposed joint design and fabrication satisfies the stated requirements. The joint qualification program plan shall also include a description of the proposed joint design with any evidence derived from previous experience, analyses or testing, that the design satisfies the requirements of this specification. The Seller shall schedule the implementation of the program such that unexpected results do not adversely impact the RSG fabrication schedule. When completed, the joint qualification report shall be submitted for Purchaser approval.

304.9.6 Tube Supports

Tube support elements which make contact with the tubes shall not utilize carbon steel.

Tube support design shall be designed to minimize foreign material deposit buildup and steam traps which may result in steam blanketing and prevent damage or wear of tubes due to vibration.

Tube supports shall be designed such that the maximum unsupported tube length is acceptable with regard to flow induced vibration. The diametrical gap between tubes and U-bend supports shall be minimized. The Seller shall demonstrate that all tolerances and clearances are maintained after the RSG is moved from the horizontal to vertical position.

As part of the RSG internals analysis, it shall be proven that the tube support system is adequately designed for LOCA, and steam and feedwater line breaks plus seismic loadings. It is also important, with regard to tube supports, to reiterate the requirement that RSG internals shall be designed to accommodate chemical cleaning of the RSGs every five effective full power years. The Seller shall provide evidence that tube supports are resistant to corrosion effects and failure as a result of stress corrosion cracking.

Tube supports shall be designed to avoid dryout at a tube-to-support intersection. The Seller shall specify to the Purchaser the parameters of "minimum dryout." The Seller shall state the maximum anticipated superheat at a tube-to-support intersection.

Tube supports and flow distribution elements (if used) shall be configured to maximize flow adjacent to the tube and to maintain the desired pressure drop. Tube support designs that reduce pressure drop in the bundle and increase circulation ratios are preferred within the constraints of induced detrimental tube vibration or wear.

To ensure tube bundle assembly and operation without tube damage, all tube contact regions shall be deburred and support edges rounded.

The U-bend support assembly procedure shall be submitted by the Seller for review and approval by the Purchaser prior to bundle assembly. This procedure shall include means to verify that all tubes are properly supported as designed.

304.9.6.1 Vibration Within the Tube Bundle

The Seller shall provide a Vibration Report for Purchaser approval including an analysis for flow-induced and turbulence-induced vibration throughout the tube bundle and U-bend regions to show that fatigue failures, and excessive tube fretting and tube wear or wear of other RSG internals will not occur. Analysis of the effects of peak local flow in the bundle during steam outlet critical flow conditions shall be included. Effects of tube plugging on local flow/velocity shall be considered in tube vibration analyses. The tube bundle arrangement and supports shall be designed to ensure that the effective cross-flow velocity for any section of any tube will not exceed 75% of the effective fluidelastic critical cross-flow velocity (see Connors, "Flow Induced Vibration and Wear of Steam Generator Tubes," Nuclear Technology, Vol. 55, November, 1981 for definition of terms), when using conservative Beta factors proven by test results/past experience. The cited requirement shall also be imposed for the case of reduced damping associated with deposit buildup in gaps between tubes and supports in tube supports (including the case in which a tube or tubes actually become locked in the support) and the case of lack of contact at the single most critical tube support. In addition, the effects of circulation ratio on tube vibration shall be evaluated.

Any analytical techniques employed in evaluations shall be mutually agreed between the Seller and Purchaser.

The cited requirements shall apply during transient conditions which may result in increased steam flow for a period of time sufficient to allow significant tube fatigue damage, as well as to steady state operation. As a minimum, the following transients shall be evaluated:

1. Main steam isolation valve closure
2. Stop valve closure
3. Turbine trip
4. Reactor trip
5. Opening of atmospheric dump and turbine bypass valves
6. Operation on less than all reactor coolant pumps or any other condition whereby the steam flow rate from any individual RSG must be administratively limited.

In the Vibration Report, the Seller shall provide results of analyses, modeling, and tests performed to demonstrate that detrimental flow-induced tube vibration and tube/support/flow distribution baffle damage will not occur over the full range of operating conditions. The methods used to determine overall and detailed flow characteristics shall be given, and the methods of predicting local tube and other internals vibration and trends shall be provided.

In addition, the Seller shall provide analytical and experimental justification demonstrating that excessive tube wear does not occur with designs selected for tube supports and flow distribution elements. The justification shall be documented in the Vibration Report. The following subsections detail specific areas of concern with regard to tube wear.

Seller shall provide specific information concerning tube diameter, number of tubes, tube pitch, maximum unsupported length of tube (in both straight and U-bend region), nominal tube to support gaps and tolerances and nominal tube wall thickness and tolerances. In addition, Seller shall submit descriptions of tube and tube placement designs, addressing, as a minimum, cited Purchaser concerns regarding tube vibration and wear, quoting pertinent experience, analyses and tests with explicit description of rationale which verifies quoted sources as relevant. In addition, Seller shall submit descriptions of the methods and codes intended for use in vibration analyses. Descriptions shall include the method of validation or verification.

304.9.6.1.1 [deleted]

304.9.6.1.2 Tube Wear in U-Bend Area and Remainder of the Tube Bundle

The design of the U-bends and remainder of the tube bundle shall be designed to prevent excessive tube wear or wear of other elements. As a minimum, adequacy regarding tube wear shall be demonstrated by comparison with actual steam generator operating experience, if available and accompanied by calculations or other information demonstrating the applicability of the experience, and by evaluation of calculations and tests. As a minimum, the following parameters shall be considered and addressed.

1. Support/tube -- materials, maximum/minimum clearances, size/configuration of support, tube span between supports.
2. Crossflow velocities, velocity distributions and mixture mass densities between tubes at each tube span between supports (considering maldistribution effects as well).
3. Crossflow velocities and pressure drops through support areas.
4. Tube diameter, wall thickness, pitch spacing and arrangement.
5. Operating time and measurements/examinations for tube wear.
6. Expectations regarding wear life.

304.9.7 Feedwater Distribution Equipment

Seller's design must accommodate existing system operating parameters regarding system operation of separate auxiliary and main feedwater nozzles.

Current parameters:

Startup: Normally performed using 240 - 260°F Main Feedwater supplied through the Main Feedwater nozzle in a forward flushing mode during heatup above 340°F through power operation.

As an alternate method, constant 70 - 90°F Auxiliary Feedwater is supplied through the Auxiliary Feedwater nozzle during heatup until no greater than 6% power.

Power Operation: Normally performed using Main Feedwater nozzle at temperatures defined in Item B2.4 of Supplement A.

For the alternate method, swap to Main Feedwater supply through Main Feedwater nozzle at 6% power (or lower) until 100% power at temperatures defined in Item B2.4 of Supplement A.

Shutdown: Normally occurs with Main Feedwater supply through Main Feedwater Nozzle through cold shutdown conditions.

Designs must also accommodate the existing feedwater control system as described in Item B2.1 of Supplement A.

In addition, the Seller shall perform a structural analysis to provide evidence that the feedwater delivery equipment shall not fail during a seismic or postulated water hammer event such that the subsequent operation of the RSG compromises the safe shutdown or long term reliability of the unit.

304.9.7.1 Deleted

304.9.7.2 Feedring Design

The Seller shall provide conclusive evidence through relevant experience, tests and analyses which address the Purchaser's primary concerns regarding adverse impact of erosion/corrosion, water and steam hammer and other damage resulting from the collapse of trapped voids, thermal stratification, mechanical and thermal fatigue failure and pressure drop across the component. Specific limitations concerning the feedring design follow.

All components of the feedwater distribution equipment shall be of all welded construction and shall be of materials which are resistant to erosion/corrosion, thermal fatigue and corrosion cracking.

Suitable access ports shall be provided in the feedring header to accommodate general inspection, repair and retrieval of loose parts.

Configuration of the system shall be such as to avoid any trapping of steam, particularly at non-vented high points, which could result in water hammer. The feedring shall be positioned such that it remains entirely submerged during normal operation. The design of the system and supports shall be sufficiently rugged to withstand any water hammer effects which may be postulated to occur. The design of the system shall prevent draining if water level falls below the feedring header. The use of bellows is prohibited. The feedring assembly shall be solution annealed and thermally treated as appropriate for the material, after all welding and forming is completed (other than final installation welds.)

Pressure drop across the assembly shall not negatively impact station specific feedwater delivery capabilities (too high or too low).

Note that all conditions and limitations previously described are applicable to the auxiliary feedwater header as well.

304.9.7.3 Main and Auxiliary Feedwater Nozzles

The main and auxiliary feedwater nozzles shall be located and oriented as specified by the Purchaser. The Seller shall provide documentation of as-built location and orientation within stated shop tolerances.

The nozzle assemblies shall be of all welded construction without gaskets or slip fits and shall be of materials which are resistant to erosion/corrosion, thermal fatigue and corrosion cracking.

Main feedwater nozzles shall be furnished with a single thermal sleeve.

Nozzle design shall utilize only full penetration welds and shall be adequate to avoid any destructive thermal gradient effects or fatigue cracking.

The Seller shall qualify the nozzles (thermal sleeves in particular) for exposure to post RSG installation PWHT performed by the Purchaser.

304.9.8 Moisture Separation Equipment

Moisture separation equipment requirements regarding steam loading, carryover, carryunder and draining are provided in this Specification. The design of this equipment shall be specified by the Seller and submitted for Purchaser's approval. This submittal shall contain sufficient information to demonstrate adequacy based on past successful experience, tests and analyses as well as sufficient detail to demonstrate the applicability of the related tests and experience. Seller shall address corrective action taken to preclude recurrence of previous unsatisfactory performance of Seller's separators in a recently completed replacement project, providing sufficient technical justification and test data to justify the design proposed for Purchaser's steam generators.

If this equipment contains perforated plates, screens or drains which may be subject to fouling, technical justification and cleaning requirements shall be provided.

The Seller shall ensure and document through relevant experience, tests and analyses that the moisture separation equipment is structurally rugged and that its function will not be inhibited by erosion/corrosion mechanisms or fouling over the life of the RSG.

All moisture separator equipment shall be capable of being visually inspected for fouling or structural damage, e.g., due to vibration/fatigue or erosion/corrosion. All moisture separator equipment shall be capable of either being repaired and cleaned in place or shall be replaceable.

304.9.9 Instrument Taps

A minimum of four (4) upper narrow range, one (1) upper wide range, four (4) lower narrow range and one (1) lower wide range level taps shall be provided on each Replacement Steam Generator. One (1) additional instrument tap shall be provided on the upper head of the steam drum penetrating the chamber between the secondary separator deck and the steam outlet nozzle. Taps shall be half couplings as specified in the nozzle table located in Supplement A. Spare taps shall be closed with caps which form part of the ASME Code pressure boundary. Location to be determined by the Purchaser at the period of detail design.

304.9.10 Blowdown, Drain Provisions and Sludge Management

The RSG shall include provisions for blowdown of water (with little if any steam) from the area at the elevation of the tubesheet compatible with existing plant systems and equipment.

Blowdown system design flow capability shall be at least one (1) percent of total feedwater flow rate continuously for normal operation and up to (3) percent for short periods (i.e., 4 days twice per year). The design of the blowdown piping and nozzles shall incorporate features to minimize the potential for damage due to erosion, corrosion, flow-

induced vibration or water hammer. RSG design shall allow blowdown at any pressure and temperature. Blowdown system design should provide improved flow distribution across the tubesheet such that sludge lancing would be required only during a chemical cleaning.

The Seller shall prepare a report for Purchaser approval which fully describes the RSG blowdown features including appropriate drawings or sketches as well as expected dissolved and particulate removal performance (with supporting data based on actual plant experience or tests). In this report, the Seller shall also provide a thermal/hydraulic analysis of the blowdown provisions, including estimated erosion/corrosion versus blowdown rate over the life of the unit. If the blowdown impurity concentrations are expected to differ from the steam generator bulk water impurity concentrations, (due to feedwater dilution, etc.), this report should also provide the relationship between the two at all power levels.

RSG design shall allow complete draining of the steam generator primary and secondary sides. Primary side drain capacity shall be in accordance with requirements of 304.9.2. The shell drain system shall be designed to provide the capability to drain the steam generator at any temperature up to and including hot standby. Blowdown system may be utilized to provide this hot drain capability.

304.9.11 Wet Layup Provisions and Shell Fluid Sampling

The Seller shall include provisions for maintaining the RSG in the wet layup condition specifically designed to ensure adequate mixing in the tube bundle. Description of the proposed design shall be accompanied by relevant experience, tests and analyses which provide conclusive evidence that the design satisfies its functional requirements. Seller shall submit descriptions of the wet layup recirculation and sampling provisions addressing, as a minimum, the ability to satisfy the intended function, quoting pertinent experience, analyses and tests with explicit description of rationale which verifies quoted sources as relevant.

The Seller shall also include provisions for obtaining representative water samples from the tube bundle region and blowdown fluid (separately). Sampling capability should not be restricted by RSG conditions (power operation versus layup.)

The proposed designs shall be submitted for Purchaser approval and shall minimize impact on existing interfacing systems such as blowdown, chemical addition, chemistry sampling and auxiliary feedwater.

304.9.12 Steam and Feedwater Flow Limiting Devices

The Seller shall supply each RSG with an integral steam nozzle flow limiting device to limit flow from the RSG after a postulated steam line break as well as another flow limiter to limit pipe break flow in case of a feed line break.

The pipe break flow limiting characteristics and the normal operating flow/pressure drop characteristics shall be the same as in the existing design for both these flow limiters. The Seller shall recommend the designs of these flow limiters so as to prevent undue noise and turbulence during normal operation. A separate flow limiting device is not required (especially in the feed line) if other hardware in the flow path of the RSG will achieve the required flow limiting and pressure drop characteristics noted above.

The Seller shall submit the designs of these flow limiters for Purchaser approval, including pertinent technical justification which demonstrates all requirements of this specification are met.

Calibration of Steam Flow Restrictor

As an option, the Seller shall provide a calibrated steam flow restrictor that has been calibrated in accordance with ASME code requirements and can be used for secondary side calorimetrics in lieu of the feedwater flow venturis which have a tendency to foul. Purchaser required accuracy on nozzle flow coefficient, 'K', is ±0.5% at 100% of nominal steam flow. Deliverables of this option are design calculations, instrument tap locations, test procedures and resultant data.

304.9.13 Nozzles and Connections

The Seller shall furnish the required nozzles and miscellaneous connections as indicated herein and in Supplement A. All nozzles are to be fabricated with safe end or nozzle body (in the case of nozzles without safe ends) materials selected to be compatible with modern installation practices and methods.

304.9.13.1 Wet Layup/Chemical Cleaning Nozzle - Deleted.

304.9.13.2 Auxiliary Feedwater Nozzle - One nozzle outside wrapper suitable for operation. Seller shall design internal piping for auxiliary feedwater delivery to maximize cold water distribution and minimize thermal shock to wrapper assembly, primary and secondary separators, secondary shell, tube bundle. Cold water interaction with water level instrument taps shall also be minimized.

304.9.13.3 (Main) Feedwater Nozzle - One nozzle outside wrapper qualified for operation with and without the auxiliary feedwater.

304.9.13.4 Miscellaneous Design Criteria

304.9.13.4.1 Caps and plugs for optional nozzles shall be designed and qualified as part of the pressure boundary of the pressure vessel. Cap and plug design shall be as such to facilitate Purchaser's removal under field conditions.

304.9.13.4.2 Design of weld end connections shall be submitted for Purchaser approval with appropriate time for review (minimum of thirty days) without impacting fabrication schedule.

304.9.13.4.3 Sleeve Type Nozzles

Per this paragraph, a sleeve type nozzle is defined as a nozzle consisting of a sleeve, typically of corrosion resistant material, which penetrates the pressure vessel wall and is structurally attached and sealed by a weld at the inside diameter of the vessel (usually to the vessel and its cladding). The Purchaser considers it undesirable to use this type nozzle; however, if used, Purchaser approval is required and the following requirements shall be met:

An Inconel weld buildup pad shall be provided on the outside of the vessel around the nozzle sufficient for future welding to the nozzle for sealing and structural load capability per ASME Code requirements, in case of future nozzle cracking or leaks in the vicinity of its weld at the inside diameter of the vessel. This pad shall be provided before vessel stress relief and shall have undergone suitable nondestructive testing including ultrasonic test per applicable ASME Code requirements.

Inconel 600 shall <u>not</u> be used for such nozzles.

304.9.14 Tube Bundle Entrance and Flow Distribution Elements

The Seller shall submit, for Purchaser approval, an evaluation to demonstrate that the downcomer, the tube bundle entrance area and flow distribution element configurations will not tend to concentrate deposits on tubes or flow port areas and will not cause wear, excessive vibration or fatigue of the tubes. This submittal shall consider the effects of tubesheet/tube deflections as well as tolerance effects to ensure no undesired contact between flow distribution elements (or other devices in this area) and the tubes. This submittal shall contain sufficient evidence to demonstrate design adequacy based on past successful experience, tests and analyses as well as sufficient detail to demonstrate the applicability of the related tests and experience.

304.9.15 Lifting Provisions

The Seller shall provide lifting provisions for the RSG with input from the Purchaser concerning specific requirements for lifting and subject to Purchaser approval. Lifting provisions shall satisfy the following requirements:

The lifting apparatus shall be fully qualified and tested by the Seller in accordance with applicable codes and standards.

The proposed lifting apparatus shall accommodate both the existing steam generator as well as the RSG.

It is recommended that the lifting apparatus consist of two components: A bolt-on component which will attach to existing steam generator as well as to the RSGs and a trunnion integral to the RSG which accepts the bolt-on component. The Purchaser shall determine the location and orientation of the RSG lifting trunnion to maximize equipment hatch clearances and optimize on-site lifting and handling. Seller's scope does not include a spreader beam or similar device. Only lifting trunnions which can be bolted to the manways will be supplied by the Seller.

The Seller shall ensure and provide documentation that, as installed, the centerline of the lifting apparatus is perpendicular to the RSG centerline within one degree.

304.9.16 Insulation

The Seller shall be responsible for providing flexible blanket type insulation for the RSGs. An insulation specification and identification of the insulation subcontractor shall be prepared for Purchaser's review and comments and submitted to Purchaser for approval. Installation of insulation shall not cause adverse impact to the Purchaser's on-site preparatory activities during RSG installation or negatively impact the installation outage schedule proper. Heat load analysis and seismic qualification of the insulation shall be performed by Seller or insulation subcontractor with design requirements obtained from Purchaser. This is an option to the Purchaser at cost plus 10%.

304.9.17 Material Identification

All forged material subjected to pressure, such as channel heads, tubesheets, shell sections, etc., shall be legibly stamped, before fabrication, with the material manufacturer's name or symbol, the melt of slab numbers, Heat Numbers or other identifying marks, on the outside of the vessel in locations to afford visibility after fabrication. Low stress stamps shall be used.

Vessel nameplates shall be stainless steel, shall be supported on brackets away from the shell, and shall include Seller's mark and order numbers and the information required by the ASME Code. A nameplate rubbing shall be submitted to the Purchaser for approval prior to nameplate attachment. Nameplate brackets shall have adequate depth so that the nameplate will not be covered with the insulation. The nameplate shall be located so as to avoid interference with installation upending equipment; the selected site shall be subject to Purchaser's approval.

When an identifying number is assigned to a piece of equipment (other than the Replacement Steam Generator) covered by this specification, this identification shall be placed either on the equipment or on a tag securely attached to the equipment before shipment. The tag shall include the Purchaser's Purchase Order Number. If attaching the tag to the equipment is not practical, e.g., gaskets, the tag can be securely attached to the protective package of the equipment.

304.9.18 Fasteners Inside the RSG

The use of threaded fasteners inside the RSG shall be minimized in consideration of problems associated with loose parts. If threaded fasteners are used, the following is required:

The design and installation of all such fasteners must be evaluated in a report prepared by the Seller for Purchaser approval.

The detail design, including preload requirements and the materials and heat treatments used, shall be presented along with evaluations/calculations which demonstrate adequacy for all conditions. The load and fatigue capability of the fastener shall be at least as great as that of the fastened part.

The method of locking shall include a separate member which would retain any broken pieces of the fastener if cracking were to occur in the threaded, under head or shank portion of the fastener. Tack welding of the fastener directly to the fastened part is prohibited. Fasteners may be welded to the fastened parts ONLY in the locations identified in Attachment 7 where welding is called out as the locking method. Purchaser's approval shall be obtained prior to the use of fasteners in locations not identified in Attachment 7.

304.9.19 Accessories and Spare Parts

304.9.19.1 Spare Parts

All spare parts provided shall be provided with documentation which ensures that the spares are the same with respect to form, fit, function, material and method of manufacture as the original equipment.

The Seller shall provide a list of recommended spare parts which includes manufacturer's identification, materials of construction, complete ordering information, shelf life if appropriate and generic equivalents. The list shall be submitted in a bill of materials type format.

If practical, and in accordance with the principle of steam generator improvement, spare parts shall be interchangeable with the Purchaser's existing inventory.

Spare studs, nuts and washers required for primary and secondary manways shall be provided to replace all such components on one RSG per Station Unit.

The Seller shall supply (6) spare safe ends and (6) sections (3' min length) of pipe identical to the Purchaser's primary piping for use in weld mockups.

Non-manway (handhole or inspection port) studs, nuts and washers shall be provided to replace all such components on one RSG per Station Unit.

Four spare primary manway diaphragms.

The Seller shall provide the Purchaser with detailed drawings of all gaskets to enable the Purchaser to fabricate or purchase replacement gaskets. A list of Seller approved gasket suppliers shall also be provided.

304.9.19.2 Accessories

At Purchaser's option, Seller shall provide nozzle dams for one unit plus one spare (total of five) from a subsupplier based on Purchaser's specification at cost plus 10%. Nozzle dam warranty shall be as provided by nozzle dam supplier.

304.9.19.2.1 Stud Tensioners and Radiation Shield Doors

The Seller shall provide light weight, multistud tensioners and fully functional test stands and radiation shield doors to accommodate any RSG accesses which are of a size or configuration that precludes the use of the Purchaser's existing stud tensioning equipment. Purchaser currently utilizes only Flexitallic Hydratight primary stud tensioning equipment. The Seller shall submit specifications for primary and secondary stud tensioning equipment and recommended supplier for Purchaser approval. As a minimum, the following tensioners shall be provided:

- Five stud tensioners for the primary manways (18")
- Three stud tensioners for handhole ports (6")
- One stud tensioner for the secondary manway (16")
- Two stud tensioners for the tube support plate inspection ports (2")

Additional stud tensioners may be required, if additional access openings are not addressed by these stud tensioners. Purchaser approval shall be obtained prior to finalizing design where access ports requiring additional stud tensioners are included in the design.

Nine interchangeable primary manway radiation shield doors are required. Radiation shield doors shall incorporate the following design features at a minimum:

- Total assembled weight can be handled by two persons.
- Maximum single component weight can be handled by one person.
- Attenuates radiation levels by 60% at the primary manway.

- Provides for direct quick fastening of nominal 8 inch flexible ventilation hose.
- Ventilation hose attachment fitted with movable damper.
- Allows for penetration by cables or hoses while door is closed or open.
- Can be fully opened with ventilation hose installed to permit access.
- Permits maintenance on all but (4) manway mounting stud holes while installed.
- Can be installed in less than 3 minutes.
- Can be locked closed by standard pad locks.

Seller shall obtain these accessories (stud tensioners and fully functional test stands and radiation shield doors) from a subsupplier based on Purchaser's specification at cost plus 10%. Warranty for these items shall be as provided by subsupplier.

304.9.19.2.2 Mockup

The Seller shall provide a mockup of the RSG channel head area for Purchaser training purposes. Mockup design shall be submitted for Purchaser approval and shall consider, as a minimum, the following features:

The mockup shall be full scale and be representative of the RSG from the channelhead up to and including the first tube support. Representation of 100% of tubes is not required.

Carbon steel is acceptable material, except as noted.

Primary nozzles shall include safe ends for welding demonstration. These spares are counted in the (6) spares required to be provided.

All manways, handholes and inspection ports in the area of the RSG represented by the mockup shall be included in the mockup and be dimensionally accurate.

At least one manway, handhole and inspection port cover represented shall be capable of having studs tensioned with the multistud tensioner used for the RSG in service. At least one primary manway and cover shall accommodate use of the manway cover handling device used for the RSG in service. In addition, the primary manway shall accommodate installation of radiation doors and remote manipulators used or to be used by the Purchaser.

The mockup shall be supported such that safe use of the multistud tensioner is permitted and height of the primary manways above the floor represents the height of the RSG manways above the maintenance platform as installed in the Purchaser's plant.

The full depth of the tubesheet shall be represented, however, the mockup tubesheet may consist of a minimum 4 inch bottom plate and minimum 2 inch top plate, spaced to represent the full thickness of the tubesheet.

The tubesheet shall be marked in the same manner as the RSG.

The mockup shall contain test block sections (approximately 8 X 12 inches) located in the tubesheet periphery, center and adjacent to the divider plate. Note that if only one block is supplied, it must be capable of easy insertion and removal at the three locations specified.

The test blocks shall consist of full depth sections of tubesheet, clad and with tubes inserted and joined to tubesheet. Test blocks shall duplicate all materials, configuration, heat treatment and other fabrication processes used for the RSG.

Outside the test block locations tubes shall be inserted and expanded in the 4 inch plate, ensuring that the assembly is dimensionally representative of the RSG. Outside of the test block locations, tube material is not required to be representative of the RSG.

Nozzle dam rings identical to those provided for the RSG shall be installed.

The mockup shall be two pieces, separated along the divider plate, for ease of installation.

304.9.19.3 [Deleted]

304.9.20 [Deleted]

304.9.21 Tube Plugs and Stabilizers for Manufacturing Defects (Prior to RSG Installation)

The Seller shall recommend, for Purchaser approval, the detailed design and installation procedure of the tube plug, or stabilizer, and the specific tubes to be plugged or stabilized, in order to meet all requirements of this specification including the pertinent Technical Specifications and R.G. 1.121. The location/configuration of these plugs and stabilizers shall be evaluated and made such as to have a minimum effect on future maintenance operations, e.g., positioning of remote maintenance equipment. Pertinent technical justification (experience, tests, analysis) shall be provided in a report by the Seller for Purchaser approval to demonstrate adequacy of the tube plug or stabilizer to the same extent as required for installed tubes per this Specification. Stabilizers shall be used wherever needed in any case where the tube is to be plugged and if the assumption of tube severance at the defect could cause additional damage. Purchaser expects the replacement steam generators to be delivered with no tubes plugged. If more than five tubes in any generator must be plugged as a result of manufacturing defects, the provisions of the Liquidated Damages Schedule in the Terms and Conditions shall apply as applicable.

The Seller shall also ensure and identify that fabricators of fully qualified plugs, sleeves and stabilizers are available to the Purchaser subsequent to RSG installation.

304.10 Maintenance Requirements

304.10.1 Access

The Purchaser requires direct access to all areas of the RSG subject to required and probable (based on industry experience) maintenance and inspection. In addition, the Purchaser requires, as practical, direct or indirect (through remote optical means) access to inspect areas suspected or proven through industry experience to be susceptible to deposit buildup or degradation mechanisms such as cracking, erosion, corrosion or wear. To emphasize, access includes RSG internal, as well as standard external, accommodations.

Location of external access shall consider physical constraints presented by the Purchaser's plant.

The design of the closures shall be specified by the Seller so as to achieve adequate gasket preload to prevent leakage. This preload shall be in excess of the minimum required by the ASME Code. Analyses/comparisons with test results shall be furnished by the Seller for Purchaser information to ensure against leakage at handholes and manways.

Studs, nuts, and washers used for manway closures and handholes shall each have unique identification marks. Bolts shall not be used for any pressure boundary handhole or manway closures including covers for wrapper ports. All studs shall incorporate provision for elongation measurements (where feasible) and UT examination (for defects and for stresses during torquing) of the installed stud. The recommended lubricant for all studs and nuts shall be specified by the Seller and submitted for Purchaser approval. The Seller shall provide strain and torque requirements for all studs and nuts using the Purchaser approved lubricant to enable the Purchaser to manually torque individual studs in emergency situations where the multistud tensioner is inoperative, impractical or unavailable. Studs and nuts shall be designed to accommodate use of a multistud tensioner.

Primary manway studs shall be of one piece construction (welding is not permitted) and incorporate elongation rods for identification of accurate tension. All other studs shall incorporate means (machined flats) to allow UT of studs to determine proper tension.

At Purchaser option, the Seller shall provide features for primary and secondary manway covers to facilitate their removal, installation, handling and storage (i.e., davits, swinging or sliding supports attached to the RSG shell.)

All pressure boundary openings in the RSG shall be gasketed and their closures provided with a corrosion resistant diaphragm which has an electropolish (or other, at Purchaser's option) finish on the wetted surface. The diaphragm shall have provisions for secure placement during access cover installation. The design of closures shall be such as to

allow seal welding of the diaphragm subsequent to RSG installation. At the Purchaser's option, diaphragms will be identified which are to be seal welded by the Seller prior to RSG delivery. Features shall be provided to ensure that access covers are installed in the proper orientation (i.e. correct side out) and accommodate required handling devices. All pressure boundary gasket seating surfaces shall have a minimum 0.375 inch thick corrosion resistant cladding, satisfying all other cladding requirements addressed in this specification. The cladding for all gasket seating surfaces shall be such as to allow machining and weld deposit buildup for maintenance of these surfaces for the life of the RSG.

Helicoil repairs for manufacturing defects are prohibited, however, pressure boundary closures shall be qualified for helicoil repair after the RSGs are placed in service.

The Seller shall qualify other areas of the RSG, specifying size and location, for in service addition of pressure boundary penetrations.

It is recommended that the Seller provide manways with configuration identical to the Purchaser's existing equipment to allow the Purchaser to continue use of existing stud tensioning equipment.

The Seller shall include:

- One 18 inch primary manway in each side of the channel head of each steam generator
- Two 16 inch manways on the steam drum of each steam generator @ 180°
- A minimum of six, minimum 6 inch handholes located to permit inspection and sludge lance of the secondary face of the tubesheet
- Two 2 inch inspection ports at each tube support plate (located suitable for use for support plate sludge lancing) @ 180°
- Inspection access to feedring header internals
- Inspection access to moisture separation equipment.
- Inspection access to the top of the tube bundle.

304.10.2 Preventive Maintenance

The Seller shall recommend, for Purchaser information, the methods and frequency for preventive maintenance techniques which should be applied. As a minimum, during the first refueling outage following replacement, maintenance shall include visual inspection of one of the sludge collectors and sludge lancing of all four tubesheets. The frequency of future sludge collector cleanings and tubesheet sludge lancing will be based on data obtained during the first outage, future plant operation experience, and mutually agreed criteria (e.g., 20 lbs of sludge per generator at top of tubesheet). (Sludge collector cleaning frequency will not be required more often than once per five years.) In addition, Seller shall recommend future preventive maintenance activities which are shown to be beneficial based on adequate testing and/or experience.

The Seller shall recommend for Purchaser information the conditions under which the RSG is to be maintained when not operating, including periods of storage, installation, cold shutdown, wet lay up, and dry lay up. Special provisions for achieving these conditions shall be described by the Seller in a report for Purchaser information.

The Seller shall incorporate into the design of the RSG, features necessary to facilitate sludge removal specifically from the tubesheet and tube supports and the general operation of chemical cleaning.

The Seller shall provide a report for Purchaser approval which details the design and access for sludge lancing together with an evaluation of the effectiveness of the design, including the effects of tube layout, tube pitch, and tube lane blocking devices, if any, and experience with a similar tube arrangement in an actual steam generator. As a minimum, this report shall provide sufficient information to justify a high degree of confidence that the RSG design can be adequately sludge lanced. In addition, the Seller shall be responsible for provision of a mockup suitable for demonstration of sludge lancing operations.

If tube lane blocking devices are utilized, they shall be permanently installed, not requiring removal for maintenance.

The Seller shall include provisions for mounting acoustic sensors. This mounting system shall be compatible with the existing loose parts monitoring system. Locations and mounting details shall be provided by the Purchaser.

Each RSG shall incorporate design features which will permit the maintenance and repair radiation exposures to be As Low As Reasonably Achievable (ALARA) following the philosophy and requirements of R.G.s 8.8 and 8.10. The Seller shall specifically document these features in the Topical Report.

Weld surfaces and adjacent base metal material shall be prepared to accommodate ultrasonic testing with weld crowns ground flat and smooth with adjacent base metal. The finish shall be minimum 125 RMS.

304.11 Material Requirements

304.11.1 Acceptable Materials

Pressure boundary materials shall conform to the requirements of ASME III, Division 1 and 10 CFR 50, Appendix B for RSGs and shall be certified as required in NCA-3867.4, 3867.5, and 3867.6 and ASME III. Nonpressure boundary materials shall meet the requirements of ASME II, ASTM, or ANSI Standards. Safety-related nonpressure boundary materials shall be manufactured under a QA program in accordance with 10CFR50, Appendix B.

A list of all materials (including heat treatments) shall be submitted by the Seller for the Purchaser's approval. The Seller shall provide relevant test data and/or in service performance experience to demonstrate that all materials, processing and heat treatments are adequate for the intended environment and service life. In particular, the Seller shall demonstrate by test or analysis that the materials incorporated into the proposed RSG design are compatible with regard to such items as fabricability, thermal expansion, and corrosion resistance.

Material certification for all materials used shall be included in QA documentation submitted to the Purchaser at a time prior to RSG shipment sufficient for any Purchaser concerns identified to be addressed without RSG delivery delay.

For all materials which will contact primary system water, the cobalt content shall be 0.1% maximum, by weight and shall be documented and reported to the Purchaser for information.

Weld deposit cladding shall be Type 309L for the first pass and Type 308L for subsequent passes or I152 / I52 for cladding of the channel head, its nozzles and manways as well as for cladding of vessel and head gasket seating surfaces on both the primary and secondary sides.

Tubesheet cladding shall be recommended by the Seller for Purchaser approval, although an automated Inconel related (I52 cladding in particular) is recommended.

Channel head, tubeside and shellside pressure boundary materials shall be limited to SA 533 GrB Class 1 plate and SA 508 Class 3A forgings.

Fastener materials with an actual yield strength greater than 140 KSI or an actual ultimate strength greater than 150 KSI shall not be used.

Tube support material shall be demonstrated from service and/or steam generator mockup tests to be adequately corrosion resistant to resist tube denting under normal and off-nominal water chemistry conditions. Further, the support plate material shall have been demonstrated to provide an adequate tube fretting/wear couple with the tube to ensure realization of steam generator design life.

The use of Inconel 600, UNS # W86182 and N06082 weld filler metal or its chemical equivalent for welds, cladding or other parts, and Chromium or other plating processes are prohibited unless specific applications are identified and justified by the Seller and approved by the Purchaser.

304.11.2 Requirements for Ferritic Materials

Compliance with the fracture toughness requirements of 10 CFR 50, Appendix G, "Fracture Toughness Requirements," and paragraph NB-2300 or NC-2300 of the ASME Code, Section III is required for primary and secondary side pressure boundary materials. Appropriate impact or fracture toughness tests (including ASTM E208 1981 Edition drop weight test) shall be performed on pressure boundary materials (including the primary and secondary pressure boundary and welds connecting the two) to prove compliance with the ASME Code, Section III, Appendix G. Failure of the subject tests shall be identified to the Purchaser and be considered sufficient cause for Purchaser rejection. In addition, the tests shall conclusively demonstrate that primary side and secondary side hydrostatic tests can be performed at temperatures as low as 70°F. The Seller shall provide this evaluation for Purchaser approval.

The sulfur content of ferritic pressure boundary base materials shall be restricted to 0.015 percent maximum (heat analysis) and 0.018 percent maximum (product analysis).

Ferritic base material shall be tested for mechanical properties and impact or fracture toughness properties following a simulated post weld heat treatment.

Seller shall submit specifications for weld materials for Purchaser approval.

304.11.3 Requirements for Austenitic Stainless Steels

All austenitic stainless steels shall be procured in the solution annealed condition. The solution anneal method and process used shall as detailed in the applicable material specification with all required approvals. Hardness of austenitic stainless steels shall be less than 92 HRB, as received by the Seller before processing.

Wrought or cast austenitic stainless steels shall not be subjected to manufacturing processes or conditions that are known or suspected to be a cause of sensitization. If a process which may potentially result in sensitization cannot be avoided, the Seller shall:

1. Specify a stabilized grade stainless steel for the application,

OR

2. Specify a low carbon (0.03% C Max.) grade stainless steel.

AND

3. Perform a solution anneal heat treatment on the component after all potential sensitizing treatments are complete,

OR

4. Conduct ASTM A 262 Practice A and E (if necessary) on coupons of the same heats of material subjected to the sensitizing manufacturing processes to demonstrate mitigation of sensitization. Specifically, the coupons shall be subjected to the same time / temperature exposure as the manufacturing process, then tested per A 262.

To clarify, requirements are satisfied by the following combinations of the provisions enumerated above: #1 alone, or #2 and #3, or #2 and #4.

In addition, austenitic stainless steels shall not be subjected to manufacturing conditions such that cold work greater than 2% outer fiber strain is produced on wetted surfaces. Wetted surfaces are those surfaces exposed to primary water, secondary water or steam, in service. If manufacturing processes dictate that induced strain in excess of the specified limit can not be avoided, the Seller shall:

Perform a solution anneal of the component,

AND

Demonstrate that neither the manufacturing process nor the solution anneal process produces a sensitized condition by conducting ASTM A 262 Practice A and E (if necessary) on coupons of the same heats of material subjected to the solution anneal. The coupons shall be subjected to the same time / temperature exposure as the solution anneal, then tested per A 262.

Austenitic stainless steels shall not be subjected to heavy grinding or machining. If a surface is discolored by the heat of grinding or machining, the discoloration shall be removed by additional grinding or machining at feeds, speeds and pressures which do not produce discoloration.

All austenitic stainless steel castings shall have a ferrite content of 5 FN minimum to 20 FN maximum. The ferrite content shall be determined by direct measurement only, with approved and calibrated instruments. All austenitic stainless steel castings shall be solution annealed in accordance with applicable and approved material specifications.

304.11.4 Tube Material

Tube material shall be Alloy 690.

Tubes shall be seamless.

Seller shall supply to the Purchaser relevant evidence, including laboratory, model boiler, and in plant testing data to demonstrate that the fabricated tubing will provide the expected service life of the RSG. This evidence shall include operation, in normal and abnormal environments, using the design details, such as support materials and configurations to evaluate wear properties, fatigue properties and corrosion resistance.

The Seller shall establish the minimum conditions necessary (in tube material, tube processing and in-plant operation) in order to achieve the maximum resistance to primary and secondary side corrosion. Data to support proper chemical composition and tube processing (including effects on microstructure and carbide solubility and precipitation) must be presented to support any conclusions. Additionally, heat transfer characteristics including thermal conductivity and tube oxide formation (during in-plant service) shall also be shown by relevant laboratory, model boiler and in-plant testing, as being understood and considered in the design of the RSG. Where additional testing work is to occur after Contract award, to finalize tube properties and processing techniques, plans and schedules for this testing shall be submitted to Purchaser. The results of all tests must be presented to the Purchaser for acceptance prior to beginning tube material production or tube fabrication.

Further, and in conjunction with the pre production qualification program requirements addressed in Section 304.9.4.2 of this Specification , the Seller shall submit, for Purchaser approval, a complete description of the entire tube fabrication process from material melting through shipment including detailed purchasing documents/instructions to the Seller's tube suppliers, procedures and controls to ensure a satisfactory product.

The requirements of Section 2 of EPRI Document NP-6743-L shall apply as a minimum, with enhanced requirements described in this specification. If requirements in this Specification appear to conflict with requirements in any referenced codes or documents, these conflicts shall be referred to the Purchaser for resolution prior to tube production.

304.11.4.1 Material Chemistry

The chemical composition of each heat shall be determined in accordance with ASTM E38 or alternative (as approved by Purchaser) by analysis from the ladle or remelted ingot. A product check analysis shall be performed on one piece of a randomly selected tube from each lot of finished tubing.

Chemical analysis for carbon shall be performed using the combustion gas chromatographic or infrared method in accordance with ASTM B354 or other qualified method. The method used shall have been demonstrated to accurately determine carbon concentration to within ± 0.002%. Samples for carbon analysis shall be representative of the full wall thickness, e.g., they shall be performed using material from through thickness drilling.

The chemical analysis results in percent shall be accurately reported to three decimal places.

The chemistry for ladle, check and product analyses shall be in accordance with the following:

ALLOY 690 TUBING CHEMISTRY

Element	Percent
Nickel (min)	58.0
Chromium	28.5 - 31.0
Iron	8.0 - 11.0
Carbon (ave./range)	0.020 / 0.015 - 0.025
Silicon (max)	0.50
Manganese (max)	0.50
Cobalt (ave/max)	< 0.014 / 0.016
Copper (max)	0.50
Sulfur (max)	0.010
Phosphorus (max)	0.015
Nitrogen (max)	0.05
Aluminum (Total) (max)	0.50
Boron (max)	0.004
Titanium & Tantalum (max)	0.40
Molybdenum (max)	0.2
Niobium (max)	0.1

304.11.4.2 Cleaning Water Chemistry

Water used for cleaning shall be demineralized and meet the following chemistry requirements, as a minimum:

CLEANING WATER CHEMISTRY REQUIREMENTS

Sodium ion	0.05 ppm, max
Chloride ion	0.05 ppm, max
Fluoride ion	0.05 ppm, max
Sulfate ion	0.05 ppm, max
Conductivity	2.0 micro siemens / cm, max
pH	6.0 to 8.0
Clarity	No turbidity, Oil or Sediment
Total suspended solids	0.11 ppm, max

304.11.4.3 Detrimental Materials

The tubing shall not contact materials, compounds, or elements in quantities or concentrations that could have a deleterious effect on performance or longevity of the tubing. Detrimental material controls shall be applied during all phases of tubing fabrication, tube bundle assembly and any subsequent RSG fabrication processes. Detrimental materials include, but are not limited to: lead, copper, mercury, cadmium or other low melting point metals or alloys, chlorides and red lead-graphite-mineral oil or molybdenum disulfide lubricants.

304.11.4.4 Tube Identification

The Seller shall establish and maintain a system for the identification and control of materials. These measures shall ensure that identification of the tubing is maintained by heat and lot number either on individual tubes or on records traceable to the tube during shipment and installation. For each RSG, the Seller shall provide documentation which identifies all tube locations by heat and lot number.

304.11.5 Consumable Material

A consumable material is defined as a material which comes in contact with the RSG.

The consumable materials covered by this specification include, as a minimum, adhesives, caps and plugs, desiccants, labels, leak testing fluids, general lubricants, machining lubricants and coolants, marking materials, NDT penetrant materials (i.e., those materials used in the performance of penetrant examination, including dye penetrant agent, penetrant remover, emulsifier, developer, and specified unique post-cleaning agents), rust preventatives, tapes, temperature indicating sticks, ultrasonic testing couplants, weld purge dams, welding-cutting compounds, wrapping materials including temporary insulating materials, cleaning agents, solvents, grit blast materials, grinding and cutting wheels, gloves, shoe covers, and 'snoop' solutions.

Detrimental materials such as lead, copper, mercury, and other low melting point materials, their alloys and/or their compounds, chlorides, fluorides, sulfates and sulfur shall not be included in these products at measurable levels unless identified to and approved by the Purchaser.

The Seller shall submit, for Purchaser approval, a list of all consumables within a Certified Product Report, specifically identifying and quantifying known and potential detrimental constituents including technical justification for their use. Such justification shall include pertinent test results for impurities (detrimental materials), quality control and procedures for removal if any planned or unplanned contact of the RSG with the subject materials is experienced.

304.11.6 Nozzle/Safe End Material

With the exception of the primary nozzle safe ends, the Seller shall specify appropriately qualified nozzle/safe end fabrication and materials for Purchaser approval, however, austenitic stainless steel safe ends shall not be attached to the vessel prior to PWHT. The primary nozzle safe ends shall be forged 316L stainless steel.

All terminal point connection requirements shall be as required by the Purchaser to accomplish satisfactory interface.

The Seller shall consider and address the following recommended practices:

For primary coolant nozzles, UNS # N06052 (automated process) shall be used for buttering the channel head nozzles before PWHT and forged stainless steel safe ends shall be welded to the buttering utilizing the same filler material and similar automated process after PWHT.

It is further recommended that all buttering and safe end attachment be of a qualified and automated process.

304.11.7 Detrimental Materials

It is the intent of the Purchaser to require that no detrimental materials contact the RSG. In order to realistically comply with this requirement, the Seller shall assume full responsibility for the provision of controls and sampling to ensure that any material within the RSG is not contacted by materials known or suspected to be detrimental. Further, the Seller is responsible for discovery and immediate notification of the Purchaser regarding such contact. Specifically, and as a minimum, the following prohibitions shall apply:

Molybdenum disulfide (MoS_2) or any sulfur or lead bearing lubricant shall not be used on any components

Additional and specific prohibitions are detailed in other sections of this specification (i.e., Consumable Material and Tubing .)

304.12 Fabrication

Fabrication of all RSG parts, and components shall be in accordance with this specification and Seller's Purchaser approved drawings, procedures, and reports. Dimensions and tolerances referenced on the Seller's drawings are controlled and shall be maintained. Dimensions are subject to Purchaser verification.

The Seller shall utilize only fully qualified fabrication processes and shall submit for Purchaser approval, evidence to demonstrate satisfaction of this requirement. Seller shall promptly identify any fabrication processes considered for implementation which are unproven by experience, with information which addresses the Purchaser's concerns regarding potential adverse quality and schedule impact. In any case, it shall be understood that any negative impacts realized as a result of Seller implementation of processes unproven by experience with regard to quality or schedule are entirely borne by the Seller and shall not adversely impact the quality or contracted delivery schedule of the RSG.

All pressure retaining parts/components and attachments shall be fabricated/welded (with welder and weld procedure qualification) per ASME III. All non-pressure retaining parts/components shall be welded (with welder qualification) per AWS D1.1 or per ASME IX.

304.12.1 Tube Bundle Assembly

All relevant RSG assembly procedures (i.e. alignment of tube supports and tubesheet) shall be such as to accomplish assembly of the tube bundle with 'manual' pressure only necessary to insert tubes in the bundle. All bundle assembly procedures (including assembly of U-bend supports) shall be such as to avoid any mechanical damage to the tubes. If during bundle assembly, resistance to manual tube insertion is encountered, the tube shall be withdrawn and compared to the Purchaser approved tube sample for O.D. indications for acceptability. Tubes rejectable, by comparison to the sample, shall not be utilized and spare tubes shall not be inserted until the source of the resistance is identified and the problem rectified.

Prior to bundle assembly, the Seller shall acquire and review from the tubing supplier all ECT data necessary to establish and confirm, by Purchaser's required standards, that tubes inserted into the bundle are acceptable. As required by this specification, any tubes which exhibit a repeatable ECT signal which indicates, by Purchaser concurrence, an indication of greater than or equal to 0.002 inches depth shall be rejected and not inserted into the bundle. The Seller shall acquire surplus spare tubes such that rejection of tubes according to the stated criterion shall not adversely impact the tubing of a bundle and ultimately negatively impact RSG delivery.

If tube guides or other temporary inserts are used in the RSG assembly then the Seller shall ensure their complete removal upon completion of fabrication. If lost, these guides or inserts shall be proven empirically to dissolve and disperse under hydrostatic test conditions such that exit water quality conditions for impurities are not exceeded locally.

304.12.2 Welding

Welding procedures utilized (including weld repairs and post weld cleanup) shall be qualified in accordance with the applicable codes and standards and submitted for Purchaser approval , along with pre-weld, interpass and post-weld heat treatment (PWHT) procedures prior to initiation of welding. All welds shall be performed by qualified welders. Welder qualification records shall be retained, accessible and made available for Purchaser's review upon request. The subject procedures shall include suitable instructions regarding interruption of welding or preheat; and address all requirements of this specification.

Unless approved by the Purchaser, only the following welding processes, as adequately qualified by the Seller, shall be used: Gas Tungsten Arc Welding (GTAW), Shielded Metal Arc Welding (SMAW), Plasma Arc Welding (PAW) and Submerged Arc Welding (SAW). Electro-Gas Welding (EGW) may be used if qualified for non-pressure retaining welds. Flux Cored Arc Welding (FCAW), Gas Metal Arc Welding (GMAW) or any other process not cited above, shall not be used without Seller demonstration of procedural and application adequacy and Purchaser approval.

Welding in areas of limited accessibility shall be in accordance with R.G. 1.71.

The Seller shall submit, for Purchaser approval, a description of the program for filler material control, handling and storage.

Drawings which show fabrication by welding shall indicate the joints and joint geometry generally in accordance with practices as described in AWS A2.4. Documentation shall be made available which identifies the welding procedure numbers and weld processes for each weld joint, including weld repairs.

Shielding gas purity shall be specified by the Seller, for Purchaser approval for all pertinent processes. Dew point shall be -60°F (-40°F for carbon dioxide) unless justified by the Seller and approved by the Purchaser. Shielding gas shall be employed for the FCAW process.

Electrodes for the SMAW process for welding ferritic steels shall be of the moisture resistant, low hydrogen type.

On all pressure boundary material (except tubing), all exposed arc strikes shall be removed, ground to a smooth contour and shall be examined by PT or MT for soundness. No cracks are acceptable. (Arc strikes which may occur on tubing shall be considered a non-conformance with Purchaser approval required for disposition.) Also, ground areas on the pressure boundary shall not encroach on required thickness. Reports shall be issued to document the NDE.

Weld repairs on in-process welds at a given location shall be limited to three attempts, after which a Non-conformance Report shall be issued. No welding is permitted on pressure boundary ferritic materials after PWHT unless allowed by the ASME Section III Code and approved by the Purchaser.

If plasma arc gouging or other thermal methods of metal removal are used on pressure boundary P-3 materials, a minimum 250°F preheat is required. Grinding to sound metal (minimum 1/16 inch) is required after such operations. Heavy grinding on stainless steel shall not be permitted unless Purchaser approved or followed by suitable solution anneal and rapid cooling. Any grinding shall be controlled by written procedures so as to remove any cold worked surfaces.

If gas burners are used for heating, controls must prohibit direct flame impingement unless the vessel surface is in constant motion relative to the impinging flame or a low intensity (soft yellow/blue) flame is employed with suitable monitoring equipment (thermocouples or temp-sticks) to prevent the vessel surface from exceeding 1100 degrees F. Other techniques for heating are permitted and are subject to Purchaser's review. While typical minimum heating temperature is 250 degrees F, the Seller may deviate from this standard if satisfactory justification is submitted and approved by the Purchaser. Maximum interpass temperature is 600 degrees F.

Cladding of stainless steel onto low alloy steel shall be performed per Purchaser approved Seller's procedures with a minimum preheat temperature of 250 degrees F. Final clad layers shall have an FN of 5-12 and shall be measured in accordance with ASME Section III.

All clad surfaces on the channel head, its nozzles and manways and the tubesheet shall be weld deposit of at least two layers and machined or flappered to a 63 RMS or better finish.

Clad thickness shall be at least 1.5 weld layers after machining and in no case less than 0.15 inch thick. The area of the nozzle dam seal seating can be up to 250 Ra finish.

All clad surfaces for gasket seating shall be by weld deposit of at least two layers and machined per gasket requirements with a minimum thickness of 0.375 inch.

All clad surfaces shall be ultrasonically (UT) inspected for bond and flaw. Inspection procedures and acceptance criteria shall be submitted for Purchaser approval. Clad thickness shall be measured by UT or mechanical means if submitted and approved by the Purchaser. Clad thickness shall be measured from the original base metal surface.

The locations of all weld seams shall be such as to avoid intersection with nozzle or access opening locations as permitted by the RSG design.

All welds, including nozzle attachments, shall be ground to remove discontinuities and stress concentrations. All grinding shall be performed prior to required PWHT unless otherwise approved by the Purchaser.

All welds which require ISI shall be finished and contoured to permit UT without additional surface preparation. As a minimum, the surfaces shall be free of weld spatter and slag and shall have a surface finish of 125 Ra or better for a distance of 2.5t (where t is the thickens of the base metal) plus 2 inches on both sides of the weld edges and inside/outside the vessel.

Oxy-fuel cutting shall not be used on nickel based or austenitic stainless steel materials. After oxy-fuel, air arc or plasma arc cutting of ferritic steels, a minimum 1/16 inch of material shall be removed from the scarfed edge or surface by machining or grinding.

Tools for base metal preparation and cleaning of nickel based or austenitic stainless steel materials shall not have been used on any other material.

Solvents used for base metal cleaning shall be analyzed for contamination and shall be restricted to demineralized water, denatured ethyl alcohol, isopropyl alcohol, methyl alcohol or acetone. Use of alternate solvents requires Purchaser's approval of a justification submitted by the Seller.

Welds end preparations shall be liquid penetrant (PT) or magnetic particle (MT) inspected (applicable to pressure boundary welds only). Edge discontinuities, such as laminations exceeding 1/4", shall be handled in accordance with ASME III NB-5130.

Weld end preparations shall be adequately protected at all times from mechanical damage such as may occur during movement of the component or contact with another component being moved.

In general, the use of temporary and tack welds is forbidden, however, acceptable applications are subsequently described, however, in any instance where a temporary or tack weld is utilized, weld procedure and welder qualification and preheat requirements remain as required for permanent welds. If it is necessary to use temporary welded attachments for fixturing of a weld joint or for work piece manipulation, the attachments shall be of a material equivalent to the base material. In the case of both permanent and temporary attachments to P3 material, both P1 and P3 class materials are deemed to be equivalent. Weld filler for temporary attachments and tack welds shall be the same as that qualified for the pressure boundary joints.

The temporary attachments shall be removed by grinding or thermal cutting. If thermal cutting is used, the attachment shall be cut no closer than 1/4 inch from the member and the balance removed by grinding. After removal, the area shall be MT or PT inspected clear.

Tack welds used to hold wedges to a groove face shall be removed by grinding flush with the groove face profile. Tack welds used to fuse the root shall be suitably contoured for fusion with the root pass. When tack welds are to become a part of the finished weld, welding shall be performed by a qualified welder and removed if defective. No welds of uncontrolled configuration such as tack welds shall be permitted on the finished part.

304.12.2.1 Welding of Stainless Steel

The requirements of R.G. 1.31 shall be followed for welding austenitic stainless steel. The requirements of R.G. 1.44 are covered in this specification.

All ASME Code welds performed between austenitic stainless steel and ferritic steels or nickel based alloys shall be performed with ASME II, Part C, SFA 5.14 ERNiCrFe-7 filler material (UNS # N06052) Alternately, for manual welding, UNS # W86152 covered electrodes as allowed by Code Case W92-34 can be used for both Code and Non-Code welds. Stainless steel filler material used to join austenitic steel materials or for such repairs shall conform to R.G. 1.31 with a delta-ferrite requirement for the deposit of 5-12 FN. All austenitic stainless steel and Inconel filler metal shall have a maximum cobalt content of 0.1%. Austenitic stainless steel fillers shall limit the maximum carbon content of 0.03% for wire and 0.04% for covered electrode.

304.12.3 Post-weld and Other Heat Treatments

The Seller shall submit, for Purchaser approval, the Seller recommended PWHT procedures including description of implementation of the procedure within the RSG fabrication sequence. If a PWHT procedure involves heating the tube bundle, the Seller shall indicate precautions and controls necessary to prevent overheating of the tubes or tube to tubesheet joint.

The rules of ASME Code Section III shall apply to hold time, heating rates and cooling rates except that the use of lower temperatures for longer hold times is prohibited.

When welding pressure boundary ferritic steels which require PWHT, the weld procedure shall require a minimum 20 hour PWHT for the qualification testing although the Seller shall maximize actual qualification time. Each pressure boundary ferritic steel weld shall have complete documentation of the total time qualified, the total time at temperature, and the temperature of all PWHT performed up to the time of delivery of the component. Preheat/interpass temperature of low alloy steel shall be in accordance with R.G. 1.50 and not less than values in Appendix D of ASME III.

The maximum hardness of any part of any heat affected zone for any pressure boundary weld of ferritic steel shall be Rockwell C28 (or equivalent.) The Seller's procedure to satisfy this requirement shall be submitted for Purchaser approval.

305 CLEANLINESS, PACKAGING, SHIPMENT, AND STORAGE

305.1 Cleanliness

The Seller shall assume full responsibility for the cleanliness of the RSG, including loose parts accountability and contact of components with known or suspected detrimental materials,(at Purchaser approved, detectable levels). Recognizing that the Purchaser's receiving inspection is cursory, the Seller shall also accept full responsibility for costs associated with discovery and repair of damage or cost of removal resulting from contamination, foreign material or loose parts, unless proven by the Seller, to the Purchaser's satisfaction, that ingress of such materials occurred subsequent to delivery. To minimize risks associated with the stated requirement, the Seller shall provide fully documented, adequate inspections of the RSG with RSG delivery documentation. The cleanliness of the RSG during all fabrication and delivery shall be maintained in accordance with written procedures prepared by the Seller and approved by the Purchaser. The procedures shall satisfy, as a minimum, the applicable requirements of ASME NQA-1, the guidance of Regulatory Guide (RG) 1.37 and ANSI Standard N45.2.1 per cleanliness class B.

In addition, the Seller shall submit to the Purchaser, for approval, procedures for detecting, preventing and recovery/cleaning from any such contamination of the RSG or RSG subcomponent. All intermediate and final inspection and cleaning requirements shall be submitted by the Seller for Purchaser approval.

As previously stated within this specification , the RSG shall be delivered to the Purchaser in a condition such that it may be filled with water of the specified layup quality and operated with no further action required by the Purchaser (specifically, no flushing shall be necessary.)

305.2 Clean Room Requirements

A clean room or area shall be employed for assembling the tube bundle. Personnel access to the clean room shall be under strict administrative control. A tracking system shall be implemented such that all personnel, tools and consumables shall be accounted for upon each entry and exit or use within the clean room. Additional requirements for the clean room are delineated in the following articles and shall be adhered to and documented to the Purchaser's satisfaction:

305.2.1 Construction

Walls and ceiling shall be constructed of materials that provide a smooth, easily cleaned surface which minimizes adherence of dirt and dust. Paints shall be resistant to flaking and peeling. Projections and ledges shall be minimized to reduce dirt and dust accumulation. Floors shall be constructed of a grease-resistant material and be of easily cleaned construction.

305.2.2 Atmospheric Conditions

The level of airborne particulate present during assembly shall be appropriately sampled, identified and subject to approval by the Purchaser.

The clean room and all equipment such as tools, work tables, assembly stands, and fixtures shall conform to the detrimental material and foreign material controls of this specification.

Equipment and vehicles permanently operating within the clean room shall be maintained clean to preclude contamination of hardware. Where necessary, drip pans for oil or grease shall be appropriately provided for such equipment.

305.2.3 Clothing

All personnel entering the clean room shall wear clean overalls or smocks without pockets, except as necessary for special detecting equipment, buttons, or badges and similar items. Clean shoe covers shall be employed prior to entering the clean room. Cotton or other protective gloves shall be worn if any tubing or stainless steel component is manually contacted. Eating and smoking shall be prohibited. Drinking water shall be confined to restricted areas within the clean room.

305.2.4 Foreign Material Production

Operations such as machining, grinding, welding, or burning shall be shielded to isolate or confine any foreign material produced to prevent loss of cleanliness of hardware in the area. Steam generator hardware located near these or other contaminating operations shall be protected to preclude loss of cleanliness. Machine exhaust which contains oil vapor, lead, lead compounds or other detrimental materials shall be vented outside the clean room. Exceptions are exhaust from electrically driven tools or equipment under normal operation and in a good state of repair, and exhaust from hand-held, air-operated tools. When welding or brazing of parts is performed in a clean room, precautions shall be taken to control spatter, arc strikes and to exhaust welding and brazing smoke from the clean room. Frequent vacuum cleaning is essential to preserve area cleanliness. Temporary, dustproof barriers or enclosures within a clean area shall be used where necessary. During machining operations, when it is not possible to use an internal plug or seal to close an opening (such as an opening in which a plug cannot be inserted far enough to leave room for machining), forced dry, clean inert gas or air shall be used as a means of ensuring that foreign materials are precluded from entering the opening. The opening shall be exposed only when the positive pressure of the gas is sufficient to prevent entry of foreign materials. In addition, protection from any potential mechanical damage shall be implemented.

305.2.5 Inspection Requirements

Clean rooms shall be visually inspected for conformance to these requirements at one week intervals or prior to each use, whichever is less frequent. If inspection indicates that clean room requirements have not been met, the Seller shall ensure that all hardware processed since the last acceptable inspection is acceptable with regard to cleanliness, and the room shall be returned to an acceptable level prior to further RSG fabrication work.

Equipment such as tools and fixtures which contact the RSG shall be periodically inspected (obtaining wipe samples for chemical analysis) and appropriately cleaned to ensure that such surfaces contacting the RSG are free from contamination (detrimental materials.)

305.2.6 Fluid Support Systems

Cleanliness requirements for fluid support systems to the clean room shall be consistent with the cleanliness requirements of the hardware to which it will be connected. Support systems shall meet those detrimental material control requirements to the extent necessary to prevent detrimental material from being introduced into hardware. Demineralized deionized water shall meet the requirements of Section 305.3.5 of this specification.

305.2.6.1 Gaseous System

Filters to remove oil, vapor or other foreign material shall be used. Sintered powder metal filters shall not be used. Filters shall be inspected, cleaned, or replaced periodically to ensure proper operation. Air sources shall be blown into a clean catch cloth and positively compared to an approved cleanliness standard prior to use on an RSG.

305.2.6.2 Flushing

Support systems shall be flushed prior to use to an acceptance criterion applicable to the attached hardware. Support systems shall also be flushed after repair, except when the part(s) of the system to be repaired has been isolated from the remainder of the system, and the remainder of the system is maintained clean. After repair is completed, the repaired part(s) of the support system shall then be cleaned prior to reconnection to the remainder of the support system.

305.2.6.3 Capping and Plugging

Support systems not in use shall have openings capped or plugged, and labeled, except that labeling is not required for those support system openings terminating in a clean room.

305.2.6.4 Hoses

Water transfer hoses shall be checked periodically for deterioration such as cracking, chipping and flaking and shall be replaced if found defective.

305.2.6.5 Pump Cleanliness

Pumps used in support systems and lubricated by a fluid other than the pumped fluid shall be of the type which employs an air gap or other design feature which prevents contamination of the effluent. This requirement is not applicable to vacuum pumps. However, evacuation systems shall be designed to prevent foreign material from entering hardware in the event the vacuum pump should fail.

If noncompliance with effluent cleanliness requirements is discovered, hardware having been exposed to fluid from the associated support system subsequent to the previous acceptable effluent check shall be inspected for cleanliness and recleaned as required.

305.2.7 Prevention of Loose Parts from Entering Steam Generator Hardware

Loose parts shall be prevented from entering hardware by maintaining careful control and cleanliness of parts, fittings, tools and other equipment used in the assembly of the steam generator. Clean gloves shall be worn. Hearing aids, eye glasses or any other necessary personnel accessories permitted, shall be fastened securely. When the steam generator hardware is exposed during assembly or inspection, personnel shall wear clean clothing, gloves stretch fitted or sealed at the wrist, head coverings fastened securely, and shoe covers.

305.2.7.1 Accountability

A program to preclude introduction of loose parts into the hardware shall be implemented prior to tube support plate structuring and shall continue until closure of the RSG assembly. The following requirements shall apply during this interval:

a) Inspections shall be staged commensurate with structuring activities to ensure that all internal areas are inspected for cleanliness and are free of foreign objects prior to becoming inaccessible.

b) A clean area shall be utilized to limit access to the hardware during structuring operations to only those personnel, tools, equipment, and materials necessary for the activities being performed.

c) Periodic inspections shall be made in all designated clean areas. Any extraneous tools, equipment, or other materials shall be removed.

d) Records shall be prepared of all items taken into the RSG assembly interior during final closure. Each item shall be checked off the record when it is removed from the RSG. The RSG shall not be closed until all items are accounted for and the record list is approved by the Purchaser.

305.2.7.2 Plugging of Openings

All openings in the steam generator and subassemblies shall be capped, covered, or plugged when not in use. Temporary plugs or seals shall be used to prevent entry of foreign material and objects into the clean steam generators and as practical, prevent mechanical damage. Plugs and seals used for preparing the steam generators for shipment and storage shall be as specified in this specification. The steam generator shall be thoroughly dried prior to plugging or sealing.

305.2.7.3 Sticker Removal

Stickers or other devices shall be affixed to steam generator openings identifying cleanliness. Stickers shall be affixed to temporary plugs and seals in such a manner that removal of the plug or seal cannot be accomplished without breaking the sticker. Residual adhesive from the sticker shall be cleaned from the hardware surface immediately after sticker removal per Purchaser approved procedure using local application of denatured alcohol or demineralized deionized water.

305.2.8 Recovery from Loss of Cleanliness

Loss of cleanliness from RSG internal surfaces shall be considered an extraordinary occurrence; therefore, special procedures shall be established to restore cleanliness. Restoration of cleanliness is required whenever a cleanliness requirement has been violated. After detection, restoration of cleanliness requires removal of detrimental or foreign materials and reverification of cleanliness.

Much lost time can result from attempts to restore cleanliness. It is important that preventive procedures be initiated and necessary equipment be available so that cleanliness can be restored without delay. Personnel shall be indoctrinated in the need for preventing contamination and shall be familiar with the means available for recovery of cleanliness.

305.2.8.1 Detection

Contamination may be detected by the following methods:

a) Direct visual examination

b) By wiping or by flushing

c) With mirrors made of metal or plastic. Magnetic metal mirrors are preferred.

d) By passing a clean lint-free cloth or swab through noncreviced regions to detect the presence of foreign materials.

e) With closed circuit television equipment.

305.2.8.2 Removal of Contamination

Contamination of steam generator hardware within accessible areas shall be removed by one or more of the following methods, as appropriate and approved by the Purchaser:

a) Wiping

b) A vacuum cleaner with a long suction hose to reach down into small crevices or openings may be used to remove dust and small light-weight particles such as bits of glass, plastic or metal chips, the suction hose of the vacuum cleaner shall be thoroughly clean, internally and externally, before use in recovery operations.

c) An eductor, a high velocity air stream, or an aspirator are also suitable for use in removal operations.

If loss of cleanliness has occurred in steam generator hardware with inaccessible areas, the final cleaned internal surfaces of the steam generator hardware which are accessible to visual or wiping inspection shall be inspected to determine if foreign material is present. If the visual or wipe inspection detects foreign material, the steam generator hardware shall be cleaned. Disassembly, fiber optics tooling, or flushing may be required to detect and remove foreign material.

Flushing to remove foreign material is allowed only by specific approval of the Purchaser.

305.2.8.3 Reverification of Cleanliness

After removal of foreign material, cleanliness shall be reverified by visual inspection, wiping cloth inspection, or proof flush.

305.3 Cleanliness Requirements

305.3.1 Material Control

305.3.1.1 Detrimental Material

A detrimental material is one that can have a deleterious effect on performance if it contacts the hardware. Seller shall provide, for Purchaser's approval, a list of potential detrimental materials which must be controlled and the proposed concentration limits for the alloys and stainless steels to be used in the steam the generator fabrication.

Detrimental material requirements apply to all finally cleaned surfaces and to any surface prior to or during thermal treatment. Controls on mercury and lead apply at all stages of fabrication. Detrimental material requirements are applicable to all surfaces that contact the operating fluid or maintain the integrity of the operating fluid pressure boundary.

305.3.1.2 Foreign Material

Foreign material includes grit, metal, particulate matter, oil, slag, scale, rust, and fiber, but not necessarily a designated detrimental material, which can obstruct operation of hardware or cause wear or erosion.

Fabrication and assembly of hardware shall be conducted to facilitate cleaning, inspection, and maintenance of cleanliness during fabrication. Post-assembly cleaning is not an acceptable alternative to maintaining cleanliness before and during assembly. Parts shall be cleaned and maintained clean prior to assembly and maintained clean after assembly.

Documents accompanying hardware shall inform subsequent receiving organizations of the cleanliness requirements and identify inaccessible and critical areas. No foreign material is allowed.

When rust occurs on corrosion-resistant material or on faces of flanges, the cause shall be determined and corrected. The surface shall be checked for residual rust-producing material.

305.3.1.3 Acceptable Products

Acceptable products are those products which satisfy the detrimental material concentration limits of this specification. Acceptable products can be used without restriction, i.e., at any stage of fabrication.

All consumable materials shall be qualified in accordance with a procedure that has been approved by the Purchaser.

305.3.1.4 Controlled Products

Controlled products contain detrimental material in excess of the concentration limits set forth by the Seller. Controlled products may be used if one of the following conditions is satisfied:

a) No transfer of detrimental material to the surface of the hardware occurs.

b) Detrimental materials are removed and are verified to have been removed from the hardware surface prior to the stage of fabrication where detrimental material controls apply, according to this specification.

c) The Purchaser has specifically authorized use of the product.

The Seller shall provide to the Purchaser, for approval prior to use, a list of controlled consumable materials which have been qualified by documented experience for use in fabrication.

305.3.1.5 A list of critical assembly operations that might result in a loss of cleanliness is required to be submitted by the Seller for Purchaser information.

305.3.2 Cleaning Procedures

The Seller shall prepare and submit to the Purchaser for approval, prior to use, the following detailed procedures:

a) Specific cleaning and cleanliness verification methods to be used

b) Detrimental material control procedures

c) Foreign material control procedures

d) Process control procedures: Process control procedures shall include but not be restricted to the following:

d1) Water purity control

d2) Maintenance of cleanliness

d3) Minimum exposure of hardware internal surfaces to shop atmosphere

d4) Precautions taken to prevent contact with detrimental material

d5) Controls to prevent foreign material from being introduced into the hardware

d6) Periodic inspection of water transfer hoses

d7) Controls to prevent detrimental material from contacting hardware

d8) Support system cleanliness and inspection

d9) Detection and removal of foreign objects

d10) Maintenance of cleanliness immediately prior to and during welding, brazing, and heat treating

d11) Maintenance of cleanliness during tube bundle assembly

d12) Tools and loose parts accountability

d13) Cleanliness controls for tube-to-tubesheet assembly, welding, leak testing, and expansion

305.3.3 Cleanliness Inspections

Surfaces of hardware shall be inspected for cleanliness at the following times during fabrication:

a) After cleaning

b) Prior to any thermal treatments such as hot forming, heat treatment, weld preheat or metal joining operations

c) After a free iron check

d) Prior to assembly

e) During critical assembly operations that might result in a loss of cleanliness

f) Immediately prior to assembly operations where surfaces which will contact the fluid system subsequently become inaccessible for inspection

g) On completion of final assembly and prior to sealing of openings which prevents further access to surfaces that will contact the fluid system

h) After nondestructive testing

Drain water shall be inspected following shop assembly hydrotesting. Drain water quality shall meet the Purchaser's water quality requirements for wet layup. Additional circulating flushes or fills and drains shall be performed until this criterion is satisfied.

305.3.4 Special Cleanliness Requirements

305.3.4.1 Heating

When heating nickel base alloys in a manner that allows combustion products to contact the metal surface, the fuel used shall not contain more than 15 grains per 100 ft^3 of sulfur for heating of tubing; 20 grains per 100 ft^3 of sulfur for heating of steel. Heated surfaces shall be wiped down with demineralized water or approved cleaner following cooldown to ambient temperature. Analysis of wipe samples shall meet the demineralized water specification as stated in Section 304.11.4.2 to be considered acceptable.

305.3.4.2 Lubricant

Lubricants shall meet the requirements for detrimental material concentration to be recommended by the Seller for Purchaser approval. Particular care shall be exercised to remove all lubricants which contain any sulfur or halogens. Red lead-graphite-mineral oil lubricant shall not be used on nickel base alloys.

305.3.4.3 Ultrasonic Couplants

Ultrasonic couplants for final cleaned surfaces or surfaces prior to thermal treatment shall be soluble and shall be thoroughly removed by water meeting the requirements of Section 305.3.5 of this specification to prevent oxidation.

305.3.4.4 Tools

Metal removal and finishing tools shall be visibly clean, shall not contain loose material such as metal shot, and shall not have been used on aluminum, lead or its compounds, or other low melting point materials. Metal removal and finishing tools to be used on stainless steel or Inconel shall not have been used previously on carbon steel or low alloy steels.

Tools used to remove foreign objects shall not scratch or in any way damage the surfaces of the hardware.

305.3.4.5 Halogenated Solvents

Halogenated solvents shall not be used on parts or surfaces with crevices. Caution shall be taken when using halogenated solvents since decomposition into corrosive agents may occur during subsequent heating.

Halogenated solvents shall not be used for cleaning inaccessible or critical surfaces of hardware or external surfaces such as flange faces and weld preparations when the possibility of solvent entering into installed hardware exists. If halogenated solvents are used, they must be completely removed and the surfaces wetted by the halogenated solvent inspected to verify complete removal.

305.3.4.6 Acid Cleaning

Acid cleaning shall not be used as a standard procedure. Specific Purchaser approval is required for the acid cleaning of all hardware except tubing.

305.3.4.7 Flushing

Flushing is allowed only by specific approval of the Purchaser. The ability to flush dead legs and the quality of the flushing water shall be addressed. Water used for flushing shall meet the requirements of Section 305.3.5 of this specification.

305.3.4.8 Cleaning of Inaccessible Surfaces

Surfaces containing crevices or inaccessible areas, where complete drainage or removal of residuals cannot be assured, shall be cleaned only with demineralized water or nonchlorinated halogen-free solvents.

305.3.5 Water Quality

Water used for hydrostatic tests, cleaning and equipment flushes shall meet the following requirements:

HYDROTEST WATER CHEMISTRY REQUIREMENTS

Sodium ion	0.05 ppm, max
Chloride ion	0.05 ppm, max.
Fluoride ion	0.05 ppm, max.
Sulfate ion	0.05 ppm, max.
Conductivity	2.0 micro Siemens / cm, max.
pH	6.0 to 8.0
Clarity	No Turbidity, Oil or Sediment
Total Suspended Solids	0.11 ppm, max.

305.4 Protective Coating Requirements

All exposed exterior carbon steel and low alloy surfaces of each Replacement Steam Generator, except weld preparations, gasket surfaces, and stainless steel or nickel base alloys, shall be coated with a strippable material in accordance with the Seller's standard practice. The Seller shall submit a surface preparation and coating procedure, including identification of the coating system to be used, to the Purchaser for approval.

No paint shall be left on the tube bundle or any interior surface. The internal surfaces of the Replacement Steam Generators shall not be painted. Stainless steel, other corrosion resistant surfaces, and channel heads (regardless of material) shall not be painted. No paint shall be applied to surfaces adjacent to shop welds that require NDE for a length of 2-1/2 T + 2 inches on both sides of the weld edges where T = weld thickness. Edges prepared for field welding shall be coated in accordance with the requirements of Section 305.4.1.

305.4.1 Field Weld Preparation

Surfaces within two inches of any edge prepared for field welding shall be protected by applying a 0.75 to 1.5 mil film of Carbo-Weld 11, as manufactured by Carboline Co., St. Louis, Missouri, or Purchaser-approved equal. Application shall be per manufacturer's recommendations.

305.4.2 Shop Welds and Channel Heads

Channel heads, shop welds requiring NDE, and all external machined surfaces other than field weld preparations specified above shall be coated with a rust preventive coating conforming to SSPC-PS-8.01, Type B or C Compound, or Purchaser-approved equal. Coatings shall be nonwater soluble, but shall be capable of being removed by a nonhalogenated solvent. Typical products are as follows:

Coating	Manufacturer
ASTROL, RP EXTRA	Imperial Oil & Grease Co. Los Angeles, California
Rustproof Compound LF	Texaco New York, New York

Application shall comply with the requirements of SSPC-PS-8.01.

305.4.3 Uncoated Surfaces

Bolts, studs, washers, nuts, and stainless steel, and nonferrous surfaces need not be coated.

305.4.4 Masking of Surfaces

The Seller shall mask or otherwise protect those surfaces not to be coated or which receive a corrosion or rust preventive treatment as specified above prior to and during the coating operation.

305.4.5 Handling of Coated Members

Coated members shall not be handled until they have dried in accordance with the manufacturer's recommendation, except for necessary handling in turning for coating or stacking for drying. Coated members shall not be loaded for shipment or shipped until dry. Coated members shall be handled, stacked, and transported in a manner that does not damage the coating. Coatings which are damaged in handling shall be repaired in accordance with coating manufacturer's instructions.

305.5 Packaging

For completed and sealed vessels, the Seller shall comply with the packaging, shipping, storage, and handling requirements of ASME NQA-2 and ANSI N45.2.2-1972, Level D, except as otherwise specified herein, and the quality assurance requirements of Regulatory Guide 1.38. The Seller shall provide, for Purchaser's review and approval, procedures for packaging, storage, shipping, site receiving, handling, and cleaning after installation. The packaging procedure shall take into account the method of transportation to be used, as well as the possible storage duration and storage environment.

305.6 Preparation for Shipment

The Seller shall provide, for the Purchaser's review and approval, a shipping procedure which includes, but is not limited to, a detailed description of the methods of tube bundle support and nitrogen atmosphere maintenance during transit and storage.

Prior to shipment, the tube side and shell side of each RSG shall be cleaned to minimize post-installation cleaning and to ensure that, when the completed system is filled with water of the quality required by the Purchaser for wet layup, it is ready for subsequent operation. A foreign object inspection shall be performed on the shell side just prior to final closure of all openings. Equipment shall be stored, inspected, handled, installed, and cleaned by methods which ensure that harmful contaminants do not remain on any component surface in contact with process fluids.

Protection of internal cleanliness shall be achieved by sealing all openings with plugs, caps, or covers. All threaded plugs used to seal auxiliary nozzles shall be removable by the Purchaser after site installation. These items shall also be protected to preclude damage which might result in loss of nitrogen pressure or contamination. Nozzle covers shall be designed and installed such that their removal can be accomplished without damaging the vessel or pipe nozzle weld joint preparation area. At the Purchaser's discretion, manway and access ports shall be closed with either contract covers and studs or temporary shipping covers and bolting material. The Seller shall also provide the option for the RSG to be delivered with individual access port diaphragms in a seal welded condition.

The criteria specified below are applicable to all internal surfaces of each Replacement Steam Generator.

A. Surfaces having free access shall pass the following examinations: visual examination, wipe test, leach samples, and rust determination. Visual techniques shall include boroscopes, mirrors, supplementary lighting, or other aids when needed to properly examine hard-to-see surfaces:

A1. The surface shall appear "metal clean" when examined without magnification by persons with 20/20 vision (natural or corrected) under a lighting level (background plus supplementary) of at least 100 foot-candles.

A2. The surface shall be free of particulate contaminants such as sand, packing materials, sawdust, metal chips, wire, weld spatter, tape, and tape residue.

A3. The surface shall have no evidence of organic material or films such as oil, grease, paint, crayon, moisture, chemical residue, or preservatives. In addition to visual examination, the surface shall be wiped with a solvent-dampened, white, lint-free cloth, using a clean portion for each wipe. A visible discoloration on the cloth is unacceptable unless it is established that the deposit is nondetrimental.

B. If visual examination is not possible, but the surface is accessible, inspection shall consist of wiping the surface with a dry, white, lint-free cloth followed by wiping with a solvent-dampened white cloth. Visual discoloration on either cloth is unacceptable unless it is established that the deposit is not detrimental.

C. Rust on critical surfaces of corrosion-resistant materials can be indicative of defective material. The cause of rust shall be determined to prevent recurrence.

Each Replacement Steam Generator shall be completely dry to at least a dew point of ≤-20°F prior to pressurizing with dry nitrogen prior to shipment. Each Replacement Steam Generator shall be dried and "packaged" in the following manner unless an alternative procedure is approved by the Purchaser. The tube side and shell side of each RSG shall be drained and dried immediately after hydrotesting and cleanliness inspection. The Replacement Steam Generators shall be evacuated to eliminate residual moisture, and the unit shall be sealed and pressurized on both the tube side and shell side with dry nitrogen to a pressure between 5.0 and 10 psig. The nitrogen shall remain at this positive pressure and shall meet the following requirements:

Dew point	≤-20°F
Oxygen content	≤1.0%

The following note shall be stenciled with contrasting color paint on each Replacement Steam Generator near each manway and on all manway covers as a safety requirement:

DANGER: THIS VESSEL CONTAINS PRESSURIZED NITROGEN. ADEQUATE VENTILATION OF THE VESSEL IS REQUIRED BEFORE ENTERING.

Each Replacement Steam Generator shall be shipped with a nitrogen supply connected to the unit. Redundant compound pressure gauges shall be in place to indicate the nitrogen pressure in each circuit and shall also have valved connections for adding nitrogen as necessary. Closures shall be tested for leaks with soap solution. The Seller shall provide the calibration requirements and gauge ranges to monitor nitrogen pressure, the nitrogen addition procedure for supplied valving, and cleaning controls for caps.

305.7 Handling and Shipping

During shipping, installation, and handling, the Replacement Steam Generators must withstand the associated loads, including lifting and upending, and environments without damage. All shipping equipment (cradles, saddles, slide, braces, etc.) shall be provided by the Seller. In addition, the Seller shall provide rollers (devices used to rotate, or "roll" the steam generators) for four RSGs to facilitate the Purchaser's on-site installation preparatory work. This equipment shall be provided on a loan and return basis.

The Seller shall indicate the weight, center of gravity, and lifting points to be utilized for all handling procedures on the item, crate, skid, or package. Use of appropriate lifting devices shall not damage or contaminate the Replacement Steam Generator surfaces. The Seller shall indicate any limitations to be imposed when the Replacement Steam Generator is lifted or moved, including maximum allowable three dimensional accelerations, including maximum internal/ambient temperatures and pressures, during shipping.

Written instructions covering the location and stacking limits of crates or boxes on the transport vehicle shall be specified by the Seller and marked on the container.

Coated equipment shall be handled at all times with equipment such as stout, wide belt slings and wide padded skids designed to prevent damage to the coating. Bare cables, chains, hooks, metal bars, or narrow skids shall not be permitted to come in contact with the coating.

Shipment to the site shall be as specified in Supplement A. The Seller is responsible for shipment to the unloading point on Purchaser's property, e.g., barge slip or rail siding. The Purchaser will unload and transport the steam generators to the onsite storage area. All equipment shall be carefully loaded on properly padded saddles or bolsters. All bearing surfaces and loading stakes shall be properly padded. Equipment sections shall be separated so that they do not bear against each other, and the whole load shall be securely fastened together to prevent movement in transit. For rail shipments, the equipment shall be loaded and tied into a unit load in strict accordance with the current loading rules of the American Railway Association, whenever they are applicable. If the Replacement Steam Generators are shipped by rail, the Seller shall provide a rider to accompany the shipment.

In truck shipments, the equipment shall be supported in wide cradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of equipment. For smaller size equipment, sand or sawdust-filled bags shall be used instead of hollowed-out timbers.

For barge shipment, the equipment loading arrangement and tie-down shall be reviewed and approved by a marine surveyor and authorities such as the Coast Guard if necessary.

When special shipments are required, e.g., items that exceed weight limitations for railroads or highways, or require special handling, the Seller shall send a detailed procedure to the Purchaser for approval. The Seller shall be responsible for obtaining all necessary federal, state, and local permits for the transportation of all equipment to Purchaser's plant.

The nitrogen atmosphere shall be maintained throughout shipment. The Seller shall record gage readings daily during transit and provide them to the Purchaser. Nitrogen shall be added as necessary to maintain the pressure specified in Section 305.6.

Continuously recording accelerometers shall be installed to measure accelerations in all three (3) directions during transit. A report characterizing the loads and the effect on the shipment shall be prepared by the Seller and submitted to the Purchaser. The Seller shall maintain the raw data and make it available for review by the Purchaser.

305.8 Storage

305.8.1 Seller's Preparation

Each Replacement Steam Generator shall be prepared for long-term storage while at the Seller's facility. The exterior surfaces of the vessel shall be protected against rusting of the ferritic steel and corrosive attack of the primary nozzle stainless steel safe ends. The Replacement Steam Generators interior surfaces shall be protected against oxidation or corrosive attack by use of an inert dry nitrogen gas plenum. The Replacement Steam Generators assembly interior surfaces, primary and secondary, shall be clean and inspected and all vessel openings hermetically sealed with welded

covers, threaded plugs, or gasketed closures. The Seller shall provide suitable storage supports (i.e. skids or cradles) for each RSG. The storage period shall follow completion of shop fabrication and assembly commencing with initial vacuum purging and back filling of dry nitrogen gas to provide the replacement steam generator interior with the following required plenum characteristics:

Dew Point: -20°F or lower

The minimum requirements for the nitrogen is a commercial grade that does not contain more than 0.20 percent by volume of impurities and has a dew point below -67°F.

Oxygen Content: Less than 1 percent by volume, measured at double gauge gas outlet manifolds mounted on the steam generator.

305.8.2 Storage Requirements at the Seller's Facility

The Replacement Steam Generator storage shall meet ANSI N45.2.2 Level D and ASME NQA-1 and 2 as applicable, protection equivalency.

a) Facility

The Replacement Steam Generators shall be stored outdoors in a designated area marked and secured for storage, remote from heavy traffic, with access restricted to authorized personnel. The Replacement Steam Generators shall be up on saddles or cribbing to allow air circulation around the vessel and avoid condensation entrapment or ground contact. The storage areas will be properly graded, well-drained, and preferably gravel-covered or paved. Cleanliness and good housekeeping practice shall ensure no accumulation of unidentified or unauthorized material is present in the storage area.

b) Surveillance

A visual inspection of the storage area will be performed on a periodic basis. A record of inspection will be maintained and proper action taken immediately to correct all unsatisfactory conditions. Particular attention will be given to observing evidence of moisture, corrosion, chipping, cracking or loss of paint or protective coatings on the Replacement Steam Generators and the condition of cribbing or saddles. This inspection is also to include weekly documented gauge readings of the nitrogen gas pressure and vessel ambient temperature. Both primary and secondary side gauge readings are required and are of equal importance.

c) Inspections

c1) Nitrogen Plenum Inspection

Pressure gauges located on the Replacement Steam Generators tube and shell side shall be used to monitor the nitrogen gas pressure for the primary and secondary side plenums. The gauge pressure will fluctuate with temperature but is not expected to go beyond the limits in this specification. The shop pressure gauge and temperature readings will be taken and documented before and after Replacement Steam Generator movement into the storage area.

If the Replacement Steam Generator is not directly moved into the storage location, both vessel temperature and pressure gauge readings will be taken before and after each handling, since handling may break a seal and cause pressure loss.

In the event the Replacement Steam Generator gauge pressure is below the minimum positive pressure requirements, the cause shall be determined and corrective measures taken. Any gauge reading less than the minimum required pressure as defined in this specification, but greater than 1 psig will not require redrawing a vacuum. If the Replacement Steam Generator gauge indicates 1 psig or less, a nitrogen fill with dry nitrogen gas sufficient to obtain a vessel atmosphere sample will be required. Any plenum that has a zero gauge reading (lost all pressure) shall be purged and refilled with nitrogen. An interior not meeting Section 305.8.1 requirements shall be identified on a nonconformance report.

c2) Vessel Exterior Inspection

All surfaces of the Replacement Steam Generators shall be visibly inspected for signs of damage to the protective coatings and paint. Such damage would likely be in the form of scrapes, peelings, punctures, etc.

Any Replacement Steam Generator cover or vessel surface area which requires protective coating restoration shall be recoated to the original coating requirements or other acceptable protective coating alternatives.

306 INSPECTIONS, TESTS AND EXAMINATIONS

306.1 Scope

This section describes the requirements that shall be used in inspecting, testing and examining the materials used in the fabrication of the Replacement Steam Generators, the examination of the completed Replacement Steam Generators, and the examinations in accordance with the requirements of ASME Section XI.

This specification does not replace or supersede the minimum requirements of the applicable codes or standards.

306.2 General Requirements

All nondestructive examination (NDE) shall be in accordance with ASME III and ASME XI, as applicable, and the additional Purchaser's supplemental requirements contained within this specification.

In addition to the tests and other activities in this specification, the Seller shall perform any design, specification of materials, tests, inspections and other activities which the Seller considers necessary to ensure that the design, material and workmanship are satisfactory for the service intended.

306.2.1 Personnel Qualifications

Only personnel qualified and certified in accordance with SNT-TC-1A (See 202.3) as amended by ASME Section XI, IWA-2300 and ASME Section III, NB-5500 shall perform NDE. Only personnel certified as Level II or III shall interpret and evaluate the results of examinations.

In addition, personnel performing baseline ISI of tubing shall meet the requirements of the edition and addenda of the ASME Section XI Code implemented by the Purchaser at the time the inspection is performed. Personnel interpreting ECT data for the baseline ISI shall be qualified to ASME Section XI IWA-2300 Level II or higher, having satisfactorily completed specific training in data interpretation and be Qualified Data Analysts. Personnel analyzing ECT data for the baseline ISI shall complete, to the Purchaser's satisfaction, a site-specific training course established by the Purchaser. Personnel performing tests which are not addressed by SNT-TC-1A shall be qualified and certified in accordance with ANSI N45.2.6 except that they shall be high school graduates or have earned the General Education Development of a high school diploma.

306.2.2 Program Plans and Procedures

The Seller shall submit, for Purchaser's approval, the NDE program plans to be implemented to satisfy the requirements of ASME III, ASME XI, and this specification. This program shall consist of, as a minimum, tables for both sections of the ASME Code which list components and weldments versus the type of examination to be made.

Except as stated below, the Seller shall submit applicable nondestructive testing procedures including examination report forms for review and approval by the Purchaser prior to implementation. In addition, when the Seller subcontracts work including NDE required by this specification, the subcontractor's procedures shall be reviewed and approved by the Seller, prior to submittal to the Purchaser for review and approval.

The Seller shall submit procedures and techniques for performing volumetric examination (radiographic, ultrasonic, or eddy current), surface examination (liquid penetrant preferred), or visual examination for the Purchaser's approval prior to use. The Purchaser will establish a hold point to verify the technique at the onset of production testing.

If nondestructive testing procedures required by this specification have previously been submitted and approved, a statement may be submitted in lieu of the procedure which will be subject to concurrence by the Purchaser prior to implementation. The statement shall clearly identify the procedure, including revision or issue number, the date of submittal, and the project and contract number of which it was submitted. In addition, the Seller shall affirm that the procedure is exactly as previously submitted and is applicable to this specification.

306.2.3 Inspection Reports

An inspection report shall be prepared by the Seller for each required NDE and shall include the following in addition to the information required by ASME III and ASME XI:

a) Manufacturer's Name

b) Purchase Order Number

c) Name of Part and Part Identification Number

d) Method and Procedure Used

e) Records of Examination Calibrations

f) Results of Examination, including the specific size, location, orientation and disposition of all recordable indications. (Note: Code specific words only apply to the applicable code.)

g) Personnel Qualifications

306.3 Code and Specification Requirements

Materials shall be examined or tested in accordance with the requirements of ASME Section III, Subarticle NB-2500 and to the requirements of this specification. The completed vessel shall be examined and tested in accordance with the requirements of ASME Section III, Article NB-5000 and NB-6000.

Baseline ISI examinations shall be performed in accordance with the requirements of ASME Section XI (See 202.5).

306.3.1 Materials

Materials used in the fabrication of the Replacement Steam Generator shall be tested, inspected or examined in accordance with the following requirements:

306.3.1.1 Plate Material - NB-2530

Additionally, UT shall be performed to detect laminations in plate material where an attachment will be welded. The examination zone shall include the area directly beneath the weld and a distance of one-half the plate thickness on each side. The detection capability shall be an area equivalent to 1/4-in. diameter flat bottom hole. Acceptance criteria shall be submitted for Purchaser approval.

306.3.1.2 Forgings and Bars - NB-2540

306.3.1.3 Tubular Products

During manufacturing, each straight finished tube, over its full length, shall be subjected to a NDE performed in accordance to ASME III NB-2550 and NB-2560, EPRI Document NP-6743-L, and as supplemented below:

The Seller shall furnish the results of these tests to the Purchaser's representative. Any tubes with a wall thickness less than specified limits shall be rejected.

The inspection methods, speeds, and sensitivity of the examinations shall be such that they can reliably detect laminations, porosity and other defects or combination of defects with an aggregate dimension in the direction normal to the tube wall in excess of 0.002".

a) Ultrasonic Test - Tubes

Each straight finished tube, during manufacturing, shall be tested and accepted by ultrasonic methods in accordance with this specification as defined below and ASME III, NB-2552.

Tubular products shall be ultrasonically examined utilizing reference standard(s) designed and fabricated as specified in the standard applicable to the material type, size, and dimensional tolerances involved with the following additional requirements. The reference standard(s) shall be permanently identified and supplied with the material examined under this specification.

The tubes shall be examined for longitudinal and transverse defects using ultrasonic immersion technique and scanning in two circumferential and two axial directions (4-way search).

Ultrasonic flaw detection shall be incorporated into the calibration standard for defects, i.e., internal and external longitudinal notches, internal and external transverse notches.

The notches may be "V," "U" or "buttress" in configuration. For V-notches read 30° included angle for width.

The size of the calibration notches shall be compatible with the requirements for detection of defects to 0.10 mm and, in any event, shall not exceed:

Depth 0.1 mm (max)
Width 0.5 mm (max)
Length 4 mm (max)

Any tube with a discontinuity that produces an indication equal to or greater than the indication from the reference standard shall be rejected.

In addition, a continuous measurement of outside diameter and wall thickness shall be performed.

b) Eddy Current Examination - Tubes

Each straight finished tube during manufacturing shall be tested by eddy current methods in accordance with ASME III NB-2550. An eddy current test shall be performed over the entire tube length. The results of these tests will be provided to the Purchaser. Specific requirements apply to ECT determination of the required 15 to 1 signal to noise ratio. The signal to noise ratio shall be determined as specified in EPRI Report NP-6743-L Volume 2 entitled "Guidelines for Procurement of Alloy 690 Steam Generator Tubing." The following are in addition to the requirements of the cited EPRI document:

The probe shall be of internal bobbin type.
The probe shall have a fill factor greater than or equal to 0.80.
The differential coils shall have a thickness of 0.060 inch each and 0.060 inch separation.

Each as-bent and thermally treated (including inner row stress relieving as applicable) tube shall be tested with an internal probe utilizing multifrequency MIZ-18 eddy current test in accordance with Section XI of the

ASME Code and EPRI Guideline NP-6201, over the entire length (tube end to tube end). The results of these tests (recorded on optical disks) shall be retained by the Seller and a copy forwarded to the Purchaser for use by the Purchaser with a copy of software required to access the data. As stated previously in this specification, the Seller shall review the MIZ-18 data for all tubes prior to insertion in the bundle. The criterion for rejection of tubes shall be a reproducible signal which indicates a defect or aggregate of defects constituting a 5% reduction in wall thickness. Recognizing inherent difficulty in interpretation resulting from test sensitivity, the characterization of an acceptable and rejectable signal shall be as mutually agreed between the Seller and Purchaser. To reiterate, tubes which display a signal indicating a 5% or greater defect shall be rejected and NOT installed in the bundle. The Seller shall ensure that an adequate supply of spare tubes is available so that the schedule for tubing the bundle is not adversely affected by the rejection of the subject tubes.

After each Replacement Steam Generator is completely fabricated, the Seller shall perform a baseline ISI eddy current test in accordance with Section XI of the ASME Code over the entire length (tube end to tube end) of each tube in each Replacement Steam Generator and shall provide the results (recorded on optical disks and in a summary report) to the Purchaser. A multifrequency eddy current internal coil test for flaw detection and thickness gauging (equipment should include bobbin coil probe and be of the same type used by the Purchaser for ISI) shall be used by the Seller to provide high resolution and accuracy in its baseline eddy current testing of the tubing. The Seller shall also obtain and provide the Purchaser with baseline profilometry for each tube as described below. (Profilometry determination may be performed concurrently with baseline ECT). In addition, the Seller shall rotating pancake coil examinations as described below (equipment to be of the same type used by the Purchaser for ISI). In summary, the post-fabrication tubing examination requirements are as follows:

- Profilometry of tubesheet expanded region, 100% of tubes
- Eddy Current PSI inspection:
  - Full length (i.e., tube end to tube end) bobbin coil inspection, 100% of tubes, all S/Gs.
  - RPC of the hot leg top-of-tubesheet transition (+1" to -4") of 20% of all tubes in each S/G.
  - RPC of 1000 (total for 4 S/Gs) free span, U-bend, and/or tube support locations selected by HL&P Engineering. In the case of U-bend and free span locations, the inspection shall extend, as a minimum, between the two adjacent support structures. Inspections at tube supports shall extend two inches above and below the support.

All indications shall be reported. Any tube with a wall thickness reduction in excess of 0.002" depth shall be removed and replaced or plugged. It should be noted that any tubes plugged as a result of this inspection shall be considered as "Tubes Plugged per Generator" under the "Delivery Condition" Liquidated Damages Schedule in the Terms & Conditions.

Calibration of the eddy current instrument shall be accomplished by means of reference standard. The reference standard shall be prepared from an appropriate length of tubing of the same specification, size and physical condition as the tubes to be tested. Calibration shall be accomplished at the same speed at which inspection of the tubing is to be performed. The Purchaser shall review and approve test and calibration procedures. The Seller shall provide the reference standard used for final eddy current inspection to the Purchaser for use in future inspections.

The ability of the nondestructive equipment and procedure to detect defects over the entire cross section of the tube shall be demonstrated by means of longitudinal and circumferential notches on the inside and outside surfaces of the reference standard. This is in addition to the drilled hole through the wall of the reference standard used to establish rejection level.

All tubing fabricated as part of the preproduction run (as detailed in Supplement B), will receive a full length eddy current test utilizing MIZ-18 equipment as described above. This will be accomplished after the tubing is bent and thermally treated. The results of this testing will be provided to the Purchaser for his approval, prior to commencing the full production of tubing.

c) Hydrostatic Tests - Tubes

All tubes shall be individually subjected to a shop hydrostatic pressure test after bending in accordance with ASME III requirements. Any tube with leakage indications shall be rejected. The method used to dry tubes after testing shall be submitted to Purchaser for approval. In no case shall induced heating of the tube be allowed. The water used in the test shall be in accordance with Section 305.3.5.

The quality of the demineralized water used for final cleaning and flushing shall be monitored continuously using conductivity meters and shall be checked prior to use (at least once per day) for compliance to the above.

The hydrostatic test pressure shall be applied at metal and water temperature high enough to ensure that the metal is at least 60°F above its nil-ductility transition temperature (if applicable).

306.3.1.4 Castings

Casting examinations shall be in accordance with ASME Section III, NB-2570.

306.3.1.5 Bolting

Bolting examinations shall be in accordance with ASME Section III, NB-2580.

306.3.1.6 Cladding

The cladding on the steam generator seal surfaces, channel head bowl, nozzles and manways, and primary face of the tubesheet shall be ultrasonically inspected for 100% of the volume for both bond and defects in accordance with this specification and the applicable sub articles. For weld clad deposits, UT shall be performed using a calibration standard block typical of the cladding and base material. The calibration standard blocks used shall be supplied to the Purchaser when the Replacement Steam Generator(s) are delivered. Calibration for bonding and defects shall be by a 1/8-inch diameter flat bottom hole drilled through the base material and terminating at the cladding interface. Any indications(s) which produces an amplitude in excess of that obtained from the calibration hole shall be unacceptable. Weld clad deposits shall be examined in accordance with ASTM-SA578M.

306.3.2 Completed Vessel Examinations

Examination of completed vessels shall be performed in accordance with the following requirements:

306.3.2.1 Personnel Qualifications

Personnel qualifications shall be in accordance with Section 306.2.1 of this specification.

306.3.2.2 Visual Examinations

Visual examinations shall be in accordance with ASME Section III and the following requirements:

In addition to ASME III requirements, visual examination of all welds shall be performed prior to painting or other coating applications.

Procedures for visual examination of welds shall be prepared by the Seller and submitted to the Purchaser for approval prior to the implementation.

The following acceptance criteria supplement any visual weld examination criteria provided by ASME III:

a) The size, length, and location of all welds shall conform to the requirements of the specification, code, procedure, and/or detailed drawings. No welds shall be added or deleted.

b) Weld profiles shall be in accordance with the specification, code, procedures, and/or detailed drawings.

c) Thorough fusion shall exist between adjacent beads of weld metal and between the weld and base metal.

d) All craters shall be filled to the full cross-section of the designed weld.

e) Surfaces of butt joints required to be flush shall be finished so as not to reduce the thickness of the weld/base metal of the thinner weld or base metal below the required section thickness.

f) Single pass seal welds shall be free of porosity.

g) Undercut shall not exceed 1/32 inch.

h) The weld shall be free of slag and spatter except for inaccessible small areas of the upper internals. For these locations, effort to clean and remove spatter by brushing or other suitable means shall be used.

i) Cracks or blemishes caused by arc strikes shall have been ground to a smooth contour and shall have been checked after grinding to ensure soundness using MT (yoke method) or PT. No linear indications are acceptable. Ground areas shall not violate required section thickness.

Dimensional Verification

Prior to shipment of the vessel, the Seller shall verify that all external RSG dimensions identified by the Purchaser are within stated tolerances. Nozzle locations and perpendicularity to the RSG centerline are of primary concern. Further, the Seller shall provide drawings which document the 'as-built' measurements of all dimensions identified by the Purchaser.

306.3.2.3 Liquid Penetrant Examinations

Liquid penetrant examinations shall be performed in accordance with ASME Section V, Article 6 and to the applicable subarticles of ASME Section III, NB-5000.

306.3.2.4 Magnetic Particle Examinations

Magnetic particle examinations shall be performed in accordance with ASME Section V, Article 7 and to the applicable subarticles of ASME Section III, NB-5000.

The Seller shall comply with the following requirements whenever magnetic particle examination of welds is required:

a) The magnetizing current shall be rectified alternating current unless the yoke technique is approved for use by the Purchaser on a case-by-case basis.

b) Magnetic particle examination shall be performed after any required postweld heat treatment, including P1 materials.

c) Overheating or burning of the surface is unacceptable.

d) The overall circular magnetization method and the longitudinal magnetization method shall be used for bolts. The examination shall be performed after fabrication processes are completed.

If the surface to be examined is machined to a finish equal to, or better than 250 RMS, and the detection of discontinuities is critical, machined surfaces shall be examined using the wet fluorescent method.

306.3.2.5 Radiographic Examinations

Radiographic Examinations shall be performed in accordance with ASME Section V, Article 2, except as modified by the requirements of ASME Section III, NB-5000 and the supplemental requirements of this specification.

The following supplemental requirements for radiographic examinations shall be fulfilled:

a) Compliance with radiographic density limitations shall be determined using calibrated densitometers and density strips.

b) Fluorescent screens are not permitted.

c) All production radiographs shall be reviewed and approved by the Seller prior to submittal to the Purchaser's Shop Inspector (PSI). If radiographs of all affected welds are not approved by the Seller prior to PWHT, Seller is accepting the risk of the possibility that due to required repairs, the PWHT may need to be repeated.

d) Film processing practice shall be controlled in accordance with ASTM E94. Radiographs of weld repairs shall be designated with an "R" in the film identification. Film storage shall be in accordance with the requirements of ANSI NA45.2.9. Film processing and storage practice shall be identified in the radiographic procedure.

e) Completed radiographic film shall be periodically collected and delivered to the Purchaser during the fabrication process, on a mutually agreed upon periodicity (e.g., bimonthly). All radiographic film shall be submitted to Purchaser prior to the delivery of the Replacement Steam Generators.

f) The weld examination zone shall include the weld and heat affected zone. The weld heat affected zone shall be considered to extend 1/2 inches beyond the weld fusion line and the weld boundary shall be clearly indicated on the film.

g) Double film exposure shall be used on all production radiography of weldments for final acceptance.

h) The Seller shall describe the equipment to be used in radiographic testing in its proposal.

i) First time radiographic examination shall be a hold point to verify procedure compliance.

j) When radiographic examination is required, surface examination of welds shall also be performed by magnetic particle methods for ferromagnetic steels or by liquid penetrant test for non-magnetic material.

306.3.2.6 Ultrasonic Examination

Ultrasonic examination, when required by the applicable subarticles of ASME Section III, NB-5000 shall be performed in accordance with ASME Section V, Article 5.

Ultrasonic examination of clad volume and clad/base metal interface shall be in accordance with Sections 306.3.1.6 and 304.12.2 of this specification.

Scan plans of the material volume through which ultrasonic beams will pass shall be included as part of the submitted procedures. The information resulting from required lamination examinations shall be documented and provided as part of the Ultrasonic Examination Report. The area, location and distance from a reference point to all laminar reflectors shall be reported and available prior to the required angle beam examinations.

The examination volume shall include the weld and base material extending half the base material thickness beyond the weld fusion line for Class 1 welds and base material and 1/2 inch beyond the weld fusion line for Class 2 welds.

Ultrasonic examinations shall be conducted to detect laminations in plate material where an attachment will be welded and stresses created in the short transverse direction. The examination volume shall be the material directly beneath the weld and a distance of half the plate thickness on each side of the weld. The primary nozzle butter material shall be examined after welding by both straight-beam and angle-beam ultrasonic examination.

All welds, nozzles and other parts shall be configured and located so as to provide adequate access for required ASME XI inspections. The surface finish and contour of areas subject to ISI shall also be such as to facilitate ISI and eliminate the necessity for surface preparation. In addition, all welds subject to ISI shall be permanently marked by the Seller. The Seller shall submit the proposed method and extent of ISI weld marking for Purchaser approval.

The Seller shall perform baseline ISI inspections of welds and transition areas as required and in accordance with ASME Section XI. The Seller shall utilize the same inspection technique (i.e., manual, contact UT) and equipment (pulse echo) as the Purchaser to perform the subject inspections. (Details of technique and equipment will be checked when procedures are submitted for approval.) Repair of any defects discovered is fully the responsibility of the Seller. The Seller shall furnish documentation of all weld metal repairs within 3T (where T is shell thickness) of all ISI welds. Documentation shall include location and dimensions of the repair cavity. Concurrent ASME Section III and Section XI inspections may be performed, if all Code and specification requirements are satisfied.

306.4 Additional Fabrication Testing

306.4.1 Helium Leak Test - Tube to Tubesheet

The shell side shall be leak tested by means of a low pressure helium leak test prior to final tube expansion. Any tube joint weld with leakage indications shall be repaired and retested. This test procedure shall be submitted for approval by the Purchaser prior to use.

306.4.2 Dye Penetrant Test - Tube to Tubesheet

After expanding the tubes in the tubesheet, the Seller shall perform dye penetrant tests on the tube-to-tubesheet welds in accordance with ASME III, NB-5274 and to the acceptance requirements of NB-5350. Seller is not required to repeat the helium leak testing of the tube to tubesheet joints (performed prior to tube expansion) following weld repair of the tube to tubesheet welds resulting from the dye penetrant tests unless more than 10 tubes in a generator require such weld repair.

Seller may perform the dye penetrant tests prior to hydraulic expansion provided that Seller can experimentally demonstrate that stresses in welds utilizing Seller's alternate sequence are small. If Seller elects to pursue the alternate methodology, a test report qualifying the alternate method per this requirement shall be submitted for Purchaser approval.

306.5 Shop Assembly Test

The Seller shall perform hydrostatic tests in its shop as required by ASME III. A hydrostatic test pressure shall be applied to each side, as applicable, and held for a minimum of 20 minutes. The pressure shall then be reduced to design pressure and held for at least four hours while the shell side and channel head are examined for leaks. All tubes shall be hydrotested in accordance with Section 306.3.1.3. Immediately following the tests, all water shall be drained out. Drying shall be done with warm, dry nitrogen.

The shop hydrostatic tests of the Replacement Steam Generators shall be witnessed by the Authorized Nuclear Inspector (ANI) and Purchaser's Shop Inspector. No leakage indications are acceptable.

306.6 Performance Tests

After installation, the Purchaser will perform certain functional tests on the Replacement Steam Generators to verify that they comply with the requirements of this specification and are capable of satisfactorily performing the intended function. These tests shall be used as the basis for determining compliance with the terms of the Replacement Steam Generator contract performance test requirements.

The Seller shall prepare and submit to the Purchaser for review and approval, procedures for performing these functional tests. The procedures shall include details regarding accepted methods of measurement, accuracy, references, specific reference criteria, sketches, data sheets, and test equipment required if other than normal plant equipment. These tests shall be conducted in accordance with procedures approved by the Purchaser.

The Seller shall incorporate in its design, features which may be required to test or otherwise demonstrate compliance, both initially and on a routine basis. The Seller shall furnish technical consultants for the test and onsite advisory personnel for each test performed at its expense.

Seller shall identify any additional parameters not specified below for which functional tests may be recommended. The following parameters as a minimum will be verified by functional performance testing:

306.6.1 Thermal and Hydraulic Performance

Each Replacement Steam Generator will generate steam which will meet or exceed the pressure, temperature, and flow rate requirements of section 301.12 when supplied with reactor coolant and feedwater at the full load conditions specified in the thermal and hydraulic requirements of this specification. These tests will be conducted using plant installed instrumentation.

306.6.2 Moisture Carryover

Steam leaving the Replacement Steam Generators will not exceed the design basis limit of 0.10% moisture content when operating at 100% of steam flow and temperature conditions. Measurements to ensure compliance with this requirement will be made using either the Sodium 24 or Lithium tracer techniques.

306.6.3 Primary and Secondary Side Pressure Drop Measurements and Reactor Coolant Flow Rates

Tube side pressure drop, including pressure losses through the primary inlet nozzles, will result in a reactor coolant system flow that falls within the range specified in section 301.12. Secondary side pressure drop shall be measured to ensure that required feedwater flow rates are maintained. RCS flow will be measured via precision secondary calorimetric methods.

306.6.4 Water Level Control

Water level control will respond predictably and smoothly for the following transients: 10% step load increase / decrease, 5% per minute ramp increase, 40% step load reduction, and nominal reactor trip.

306.6.5 Primary to Secondary Leakage

Upon initial unit operation of the Replacement Steam Generators, leakage from the primary to the secondary side of the steam generator shall be undetectable.

306.6.6 Steam Generator Blowdown

The Replacement Steam Generators shall be able to meet or exceed the blowdown capacity for the Replacement Steam Generators identified in the plant's specific data sheets of this specification.

306.6.7 Calibrated Steam Flow Restrictor

If Purchaser chooses to exercise the calibrated steam nozzle option, accuracy will be verified via chemical tracer techniques, feedwater flow venturi (upon startup) or mass balance of steam generator inventory.

306.7 Preservice Examinations

Upon completion of the ASME III hydrotest and prior to shipment of the Replacement Steam Generator assemblies, the Seller shall perform baseline volumetric ultrasonic (UT) and eddy current (ET) and surface examinations on the inservice inspection (ISI) required welds and tubing.

For purposes of the ISI requirements, the primary side of the Steam Generators is considered to be ASME Code Class 1 pressure retaining components and the secondary side of the Steam Generators, ASME Code Class 2. The requirements of Section XI, Subsection IWB and IWC, respectively, shall apply.

The Seller shall review and consider the Purchaser's ISI specification in RSG design and actual performance of baseline ISI.

306.7.1 Scope of Preservice Inspection

The preservice examination shall be conducted prior to plant startup or restart. These preservice examinations shall be extended to include essentially 100% of the pressure retaining Class 1 welds and all Class 2 welds selected for examination in the Purchaser's program. The preservice examination shall also include 100% of the tubing.

306.7.2 Calibration Blocks

Ultrasonic calibration blocks which meet the requirements of ASME Section XI, IWA-2232, and the codes referenced therein shall be furnished to the Purchaser by the Seller. As-built drawings and material certifications shall be provided for all calibration standards furnished to the Purchaser by the Seller.

Special blocks such as mockups, if needed for complex weld joints, shall be supplied by the Seller.

Seller shall provide, as a minimum, the calibration blocks listed in Attachment 8.

Eddy current calibration standards meeting the requirements of ASME Section XI Appendix IV, shall be furnished to the Purchaser by the Seller. In addition, the Seller shall furnish wear scar and rotating pancake probe ET standards to the Purchaser for approval.

306.7.3 Examinations

Examinations shall be conducted in accordance with the requirements of ASME Section XI, IWA-2200. Written procedures and plans shall be provided by the Seller for the Purchaser's review and approval. The intent is the examinations will be conducted in a similar manner to the Purchaser's ISI methodology and with equipment equivalent to that used by the Purchaser.

SUPPLEMENT A

All information provided in Supplement A is for information only. For design purposes, Seller should verify and utilize the information from existing controlled STP documents such as the original steam generator design specification, stress reports, piping analysis, UFSAR, SER, etc.

SUPPLEMENT A - PART A
PLANT DATA SHEETS - COMPARISON SHEETS

	DATA DESCRIPTION	UNITS	ORIGINAL DESIGN DATA	REPLACEMENT DESIGN DATA (Note 1)	REMARKS
A1	**LOCATION: South Texas Project Unit 1 and 2**				
A2	**STEAM GENERATOR MANUFACTURER**		Westinghouse	Westinghouse	
A3	**STEAM GENERATOR MODEL**	model	E	Delta 94	
A4.a	STEAM GENERATOR HEAT TRANSFER AREA	ft^2	68,000 (U1) 67,818 (U2)	94550	All 8 replacement generators to have same HT surface area.
A4.b	NUMBER OF TUBES	#	4864 (U1) 4851 (U2)	7585	All 8 replacement generators to have same number of tubes.
A5.a	TUBE OUTSIDE DIAMETER	inches	0.75"	0.688" ±0.005" (±0.002" for first 25.00")	
A5.b	AVERAGE TUBE WALL THICKNESS	inches	0.043"	0.040" ±0.004"	
A5.c	TUBE MATERIAL	type	SB-163	SB163 Thermally Treated 690	
A5.d	TYPE OF TUBE PITCH	type	Square	Triangular	
A5.e	AVERAGE TUBE PITCH	inches	1.080"	0.980"	
A6	**NUMBER OF STEAM GENERATORS PER UNIT**	#	4	4	
A7	**TOTAL NUMBER OF STEAM GENERATORS TO BE ORDERED**	#		8	Total for both Units; design shall apply to both units where practical; procurement of materials and fabrication may proceed on Unit 1 only.
A8	**RSG SITE DELIVERY DATES - (A) RSG #4, (B) RSG #8**	mm/dd/yy		(A) Specified in Contract (B) not released	
A9	**PREFERRED FINAL SHIPMENT METHOD**	-		Barge	Via Colorado river.

SUPPLEMENT A - PART A
PLANT DATA SHEETS - COMPARISON SHEETS

	DATA DESCRIPTION	UNITS	ORIGINAL DESIGN DATA	REPLACEMENT DESIGN DATA (Note 1)	REMARKS
A10	**ALTERNATE FINAL SHIPMENT METHOD**	-		Rail	
A11	**UPRATED DESIGN INPUT VALUES**	%		0	Uprated SG design not requested.
A12	**CORE POWER RATING**	MWt	3800	3800	
A13	**NSSS POWER RATING**	MWt	3817 (see remark)	3821	Actual pump heat is 4 MWt higher than original design rating. Seller shall account for this.
A14	FULL LOAD OPERATING TEMPERATURES	°F			
A14.a	HOT LEG TEMPERATURE (ACTUAL/DESIGN)	°F	620.3 / 626.1 (U1) 619.6 / 626.1 (U2)	TBD	Minimum T_{hot} = 616.0, Maximum T_{hot} = 626.1 Plant operating point to be determined; warranted performance is addressed in 301.12; actuals taken from surveillance data.
A14.b	COLD LEG TEMPERATURE (ACTUAL/DESIGN)	°F	557.7 / 559.7 (U1) 556.6 / 559.7 (U2)	TBD	Plant operating point to be determined; warranted performance is addressed in 301.12; actuals taken from surveillance data.
A14.c	AVERAGE TEMPERATURE (ACTUAL/DESIGN)	°F	589.0 / 592.9 (U1) 588.1 / 592.9 (U2)	TBD	Plant operating point to be determined; warranted performance is addressed in 301.12; actuals taken from surveillance data.
A15	**RCS 0% POWER AVERAGE TEMPERATURE**	°F	567	567	No load temperature and pressure is requested not to change.
A16	**RCS PRESSURE (OPERATING)**	psia	2250	2250	No load temperature and pressure is requested not to change.
A17	**AVERAGE RCS LOOP COOLANT FLOW (BEST ESTIMATE)**	gpm	101,500	105,900 @ 0% plugged 104,300 @10% plugged	Plant operating point to be determined; warranted performance is addressed in 301.12
A18	**DESIGN TURBINE-GENERATOR ELECTRICAL OUTPUT**	net / gross MWe	1250.6 / 1311.8	1250.6 / 1311.8	
A19	**FULL LOAD STEAM PRESSURE**	psia	1100	TBD	As measured just downstream of steam outlet nozzle. Minimum steam pressure shall be 1040 psia. Plant operating point to be determined; warranted performance is addressed in 301.12.

SUPPLEMENT A - PART A
PLANT DATA SHEETS - COMPARISON SHEETS

	DATA DESCRIPTION	UNITS	ORIGINAL DESIGN DATA	REPLACEMENT DESIGN DATA (Note 1)	REMARKS
A20	FULL LOAD STEAM TEMPERATURE	°F	556.3	TBD	Plant operating point to be determined; warranted performance is addressed in 301.12.
A21	FULL LOAD STEAM FLOW PER STEAM GENERATOR	lb / hr	4,240,000	TBD	Plant operating point to be determined; warranted performance is addressed in 301.12.
A22	STEAM FLOW RESTRICTOR	yes / no	Yes	Yes	1.400 sq. ft. maximum throat area.
A22.a	FEEDWATER NOZZLE FLOW RESTRICTOR	yes / no	Yes	No	Restrictor not required unless RSG design mandates it.
A23	FEEDWATER FLOW PER STEAM GENERATOR	lb / hr	steam flow + 40,000 (blowdown)	steam flow + 40,000 min (blowdown)	Blowdown flow not considered in original performance calculations.
A24	FEEDWATER INLET TEMPERATURE	°F	440	440 (nominal) 390 (alternate)	Seller shall qualify RSG for operation with full load feedwater temperature of 390°F.
A25	FULL LOAD FEEDWATER INLET PRESSURE	psi		1100	
A26	BLOWDOWN CAPACITY, PER STEAM GENERATOR (Continuous/Max.)	lb / hr	40,000 / 120,000	40,000 / 120,000 (Also see 304.9.10)	RSG design shall not limit max blowdown capacity. Nor shall it require increased blowdown since plant systems are close to maximum capacity.
A27	FULL LOAD MOISTURE CARRYOVER	%	0.25	< 0.1	
A28	FULL LOAD MOISTURE CARRYUNDER	%		< 0.1	
A29	DESIGN PLUGGING MARGIN	%		10	
A30	STEAM GENERATOR CIRCULATION RATIO	design	2.94 (des - Unit 1) 3.01 (des - Unit 2)	see Supplement B	Without flow induced vibration / erosion problems.
A31	RCS INLET CONNECTION SIZE (I.D./THICKNESS)	inches	31 / 3.21	31 / 3.21	See nozzle table for requirements
A32	RCS INLET CONNECTION MATERIAL	-	SA-508 CL2 w/ 309L SS Buildup	SA336 316LN	Note: For primary piping mockups see 304.9.19.1
A33	RCS OUTLET CONNECTION SIZE (I.D./THICKNESS)	inches	same as inlet	see Part C	
A34	RCS OUTLET CONNECTION MATERIAL	-	same as inlet	see Part C	

SUPPLEMENT A - PART A
PLANT DATA SHEETS - COMPARISON SHEETS

	DATA DESCRIPTION	UNITS	ORIGINAL DESIGN DATA	REPLACEMENT DESIGN DATA (Note 1)	REMARKS
A35	**STEAM GENERATOR CHEMISTRY LIMITS BASED ON**	-	EPRI Guidelines	Tables 2-3a & 2-3b of TR-102134, Rev. 3 AND Table 3-2 of TR-105714, Rev 3	EPRI Guidelines: TR-102134 entitled "PWR Secondary Water Chemistry Guidelines;" TR-105714 entitled "PWR Primary Water Chemistry Guidelines"
A36	**OVERALL TUBE FOULING FACTOR**	R (cntngncy) hr-ft^2-°F / BTU	0.00005 Bundle, 0.00010 Preheater	0.00011	
A37	**DESIGN LIFE**	years	40	40	
A38	**ENVIRONMENTAL CONDITIONS**				
A38.a	NORMAL AMBIENT TEMPERATURE (min/max)	°F	65 / 120	50 / 120	Min temperature dropped to 50 deg F due to potential ventilation discharge temperatures.
A38.b	ABNORMAL/ACCIDENT AMBIENT TEMP	°F	159 / 328	159 / 350	Increase in accident temperature is to provide margin if secondary side inventory increases.
A38.c	CUMULATIVE RADIATION DOSAGE, NORMAL CONDITIONS	rads	2.00E+08	2.00E+08	Gamma and Beta
A38.d	CUMULATIVE RADIATION DOSAGE, ABNORMAL CONDITIONS	rads	1.20E+09	1.20E+09	Gamma and Beta
A38.e	EXTERNAL PRESSURE (min/max)	psig	-3.5 / 56.5	-3.5 / 56.5	Containment Accident Limit
A39.a	MAXIMUM PRIMARY SIDE PRESSURE (OP/DES)	psia	2250 / 2500	2250 / 2500	Static head, pump head and coolant pressure drop not included in these numbers.
A39.b	MAXIMUM SECONDARY SIDE PRESSURE (OP/DES)	psig	1200 / 1300	1200 / 1300	
A39.c	*deleted*				
A39.d	MAXIMUM PRIMARY TO SECONDARY SIDE DIFFERENTIAL PRESSURE (DES)	psid	1600	1600	
A39.e	MAXIMUM SECONDARY TO PRIMARY SIDE DIFFERENTIAL PRESSURE (DES)	psid	670	670	
A40.a	MAXIMUM PRIMARY SIDE COINCIDENT TEMPERATURE (OP / DES)	°F	626 / 650	626 / 650	
A40.b	MAXIMUM SECONDARY SIDE COINCIDENT TEMPERATURE (OP / DES)	°F	567 / 600	567 / 600	

SUPPLEMENT A
PLANT DATA SHEETS - COMPARISON SHEETS - PART A

	DATA DESCRIPTION	UNITS	ORIGINAL DESIGN DATA	REPLACEMENT DESIGN DATA (Note 1)	REMARKS
A43	**PLANT SPECIFIC NOTES**	-	Unit 1: 2 of 4 SGs are tilted	See notes 2 & 3 below	
A44	**S/G ASME CODE EFFECTIVE DATE**	mm/dd/yy	1974, Summer 1976 Addenda	See ASME Design Specification (later)	Expected to be ASME Section III, 1989 Edition

NOTES

1. Reference Design Data provided by Seller (table entries enclosed by heavy outline) represents preliminary design information and may be superseded by Purchaser approved design documents or by mutual agreement between Seller and Purchaser. This data shall be updated following completion of the Unit 1 replacement steam generators.

2. HL&P will do a one piece replacement.

3. Two out of four steam generators (Unit 1 only) were installed tilted. Seller shall provide consideration of this condition in seismic reanalysis.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B1 PHYSICAL CHARACTERISTICS OF ORIGINAL STEAM GENERATOR

B1.1 CONDITION	WEIGHT (LBS)	CENTER OF MASS (in.) *
DRY (CALCULATED)	912,400	365.00
NORMAL OPERATING (100% LOAD)	1,107,100	357.00
FLOODED (WATER AT 70 F)	1,490,400	366.00

* CENTER OF MASS DISTRIBUTION FROM BOTTOM OF MAIN SUPPORTS

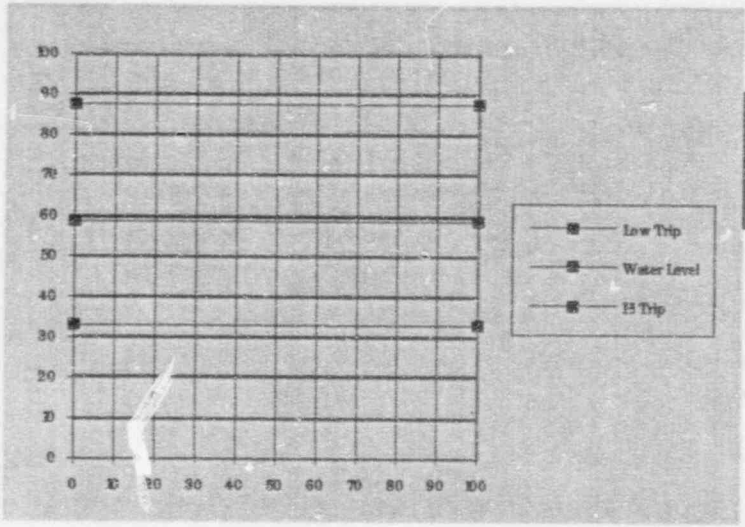
B1.2 CURRENT NOZZLE CONNECTIONS

DESCRIPTION	NO. REQ'D.	SIZE	END PREPARATION
PRIMARY SIDE INLET	See Part C		
PRIMARY SIDE OUTLET	"		
SHELL BLOWDOWN	"		
STEAM DRUM PRESSURE TAP	"		
SHELL DRAIN	"		
FEEDWATER INLET	"		
LEVEL INDICATION-WIDE RANGE	"		
LEVEL INDICATION-NARROW RANGE	"		
STEAM OUTLET	"		
AUXILIARY FEEDWATER	"		

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B2. INTERFACING CONTROL FUNCTIONS

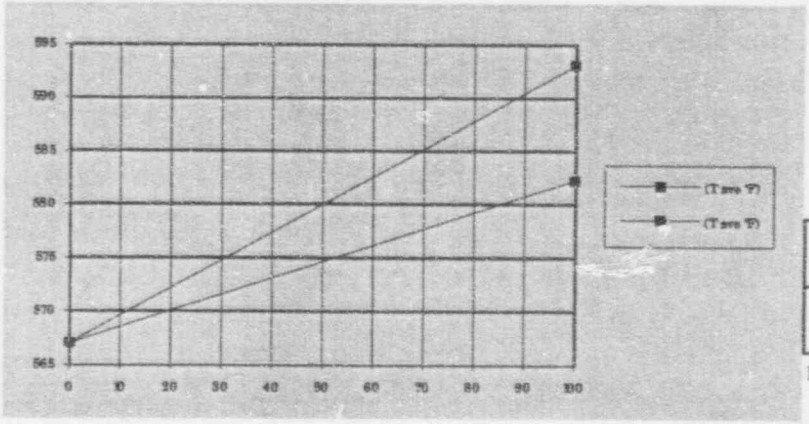
B2.1 STEAM GENERATOR WATER LEVEL CONTROL PROGRAM, SETPOINTS



% LOAD	% Narrow Range Span (179" Tap to Tap)		
	Low Trip	Water Level	Hi Trip
0	33	58.6	87.5
100	33	58.6	87.5

NOTE: Current tap-to-tap span is 179" with the lower tap placement 467.00" above bottom of support pads. Tap-to-tap span should be maintained the same, IF PRACTICAL. Azimuthal placement of taps shall also be maintained IF POSSIBLE. However, operating flexibility is a higher priority and shall govern design requirements.

B2.2 REACTOR COOLANT TEMPERATURE CONTROL PROGRAM, Before and After T hot Reduction



% LOAD	w/o Thot redxn (T ave °F)	w/ Thot redxn (T ave °F)
0	567	567
100	593	582.3

Note: Use linear interpolation for intermediate loads.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B2.3 STEAM DUMP SYSTEM (DESCRIPTION)

The steam dump system is used (1) to assist the rod control system in controlling RCS temperature and pressure following turbine load rejections of up to 50% power without causing an automatic reactor trip, (2) to remove reactor decay heat to cool the RCS back down to no-load conditions after turbine trips, and (3) during normal plant startups (up to 15% power), shutdowns and plant cooldowns to control secondary side steam pressures.

There are twelve (12) steam dump valves each with a nominal capacity of 3.33% (40% total for all twelve). The steam dumps tie the main steam header just downstream of the main steam isolation valves into the main condenser, bypassing the turbine. Each valve can go from full closed to full open in 3 to 5 seconds. The steam dump valves are arranged into four banks with equal capacity and one valve per condenser shell.

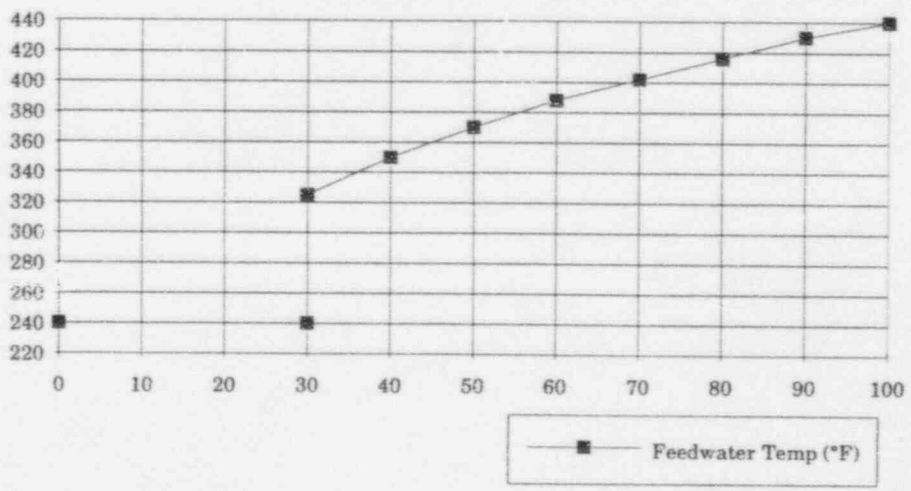
The rod control system is designed to handle a 10% step power change or a 10% ramp up or down in power over two minutes. The capacity of the steam dump system, when combined with the rod control system, permits a 50% load reduction without reactor trip.

During plant heatup and shutdown, below 15% power the steam dump valves modulate based on main steam header pressure. After shutdown, the RCS cooldown rate is controlled by adjusting the steam pressure setpoint downward.

On a turbine load reduction, the steam dumps modulate open as necessary to divert steam flow to the condenser.

More detailed design data may be provided upon Contractor's request.

B2.4 DESIGN FEEDWATER TEMPERATURE vs. LOAD



% LOAD	Feedwater Temp (°F)
30	325
40	350
50	370
60	388
70	402
80	416
90	430
100	440

Assume 240°F supply below 30% power.

NOTE: Feedwater temperature modifications may be performed to drop feedwater temp to 390°F at full power. Nozzle stress analysis shall take this into account.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B3 STEAM GENERATOR SUPPORT MEMBER LOADING

Informational Source: WCAP 9135, Rev 3

	Normal		Upset		Faulted (Note 6)	
B3.1 LOWER SUPPORTS:	Load (Note 1) kips	% of Allowable	Load (Note 1) kips	% of Allowable	Load (Note 1) kips	% of Allowable
LB-1, 2, and 3 (Beam)	--	19 (Note 3)	282	32 (Note 3)	766	50 (Note 3) 100 (Note 2)
LB-4 (Beam)	--	19 (Note 3)	282	40 (Note 3)	572	50 (Note 3) 100 (Note 2)
LS-1 and 2 (Bumper)	--	23 (Note 3)		23 (Note 3)	1174	32 (Note 3) 100 (Note 2)
LS-3 (Bumper)	--	1 (Note 3)	282	9 (Note 3)	572	15 (Note 3)
Column Assembly	+0 -405	0 28	+72 -568	6 39	+259 -1012	14/100 (Note 2) 59/100 (Note 2)
B3.2 UPPER SUPPORTS:						
US-1 (Bumpers)	--	16 (Note 5)	755	38 (Note 5)	1288	91 (Note 5)
ULS-1 and 2 (Ring Girder)	--	--	936	37	1713	45 91 (Note 2)
Snubbers (Note 4)	--	--	342	33	645	50
SB-1 (Snubber Bracket)	--	--	+240 -342	60	+453 -645	82
AFA-1 (A-Frame)	--	--	755	11 (Unit 1) 16 (Unit 2)	1356	17 (Unit 1), 26 (Unit 2), 100 (Note 2)

NOTES:

1.0 "+" = Tension, "-" = Compression

2.0 Includes jet impingement loads

3.0 Includes both the effects of attachments on the supports and loads imposed on the supports by the building structure.

4.0 Snubbers were qualified by a 500 kip upset capacity and a 1300 kip faulted capacity per snubber

5.0 Percent stressed includes building loads on the support.

6.0 Faulted = Deadweight + Press ± SQRT(SSE^2 + $LOCA^2$)
Deadweight + Press ± SQRT(SSE^2 + $MS/FW\ Pipe\ Rupture^2$)
Deadweight + Press ± SQRT(SSE^2 + $Jet\ Impingement^2$)

7.0 Reference schematics in Attachment 5.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B4 SUPPORT / EMBEDMENT ELEVATION FOR ORIGINAL STEAM GENERATORS*

** Dimensions shown below are nominal and do not represent as-built configurations.*

B4.1 BOTTOM OF SUPPORT COLUMN BASEPLATES ELEVATION: **19' 0" plus 3" grout thickness**

Reference Drawing Numbers: **1C01-9-S-1532 rev 9**

B4.2 BOTTOM OF STEAM GENERATOR SUPPORT RINGS: **37' 11"**

Reference Drawing Numbers: **14926-0957(1)00003-CWN**

B4.3 CENTERLINE OF PIN, SUPPORT COLUMN UPPER END ELEVATION: **32' 11"**

Reference Drawing Numbers: **14926-0957(2)00016-CWN**

B4.4 CENTERLINE OF LOWER LATERAL FRAME ELEVATION: **38' 4"**

Reference Drawing Numbers: **14926-0957(1)00004-CWN**
14926-0957(2)00004-CWN
1C01-9-S-1535 rev 3

B4.5 UPPER LATERAL SUPPORT

CENTERLINE OF RING BAND ELEVATION: **66' 6" (cold)**

CENTERLINE OF EMBEDMENT ELEVATION: **66' 7.5"**

Reference Drawing Numbers: **14926-0957(1)00004-CWN**
14926-0957(2)00004-CWN

B4.6 UPPER LATERAL SUPPORT CENTERLINE TRUNNION ELEVATION: **68' 11" (cold)**

Reference Drawing Numbers: **14926-0957(1)00004-CWN**
14926-0957(2)00004-CWN

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B5 MAXIMUM TENSION, SHEAR, AND MOMENT FORCES ON EMBEDMENTS

Information Source: WCAP 9135 rev 3, Appendix C

B5.1 VERTICAL SUPPORT COLUMN

DESCRIPTION	LOAD (kips, inch kips)
Normal	552

B5.2 LOWER LATERAL SUPPORT

	DESCRIPTION	LOAD (kips, inch kips)
L1	Normal	n/a
	Shear	-567
	Moment	44,508
L2	Normal	n/a
	Shear	649
	Moment	50,771
L3	Normal	n/a
L4	Normal	n/a
	Shear	505
	Moment	34,098
L5	Normal	217
	Shear	224
	Moment	19,865

B5.3 UPPER LATERAL SUPPORT

	DESCRIPTION	LOAD (kips, inch kips)
U1	Normal	1,637
	Shear	1,136
	Moment	61,353
U2	Normal	613
U3	Normal	614
U4	Normal	614
U5	Normal	327
	Shear	1,036
	Moment	70,509
U6	Normal	n/a
U7	Normal	n/a

NOTE: Reference schematics in Attachment 5.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

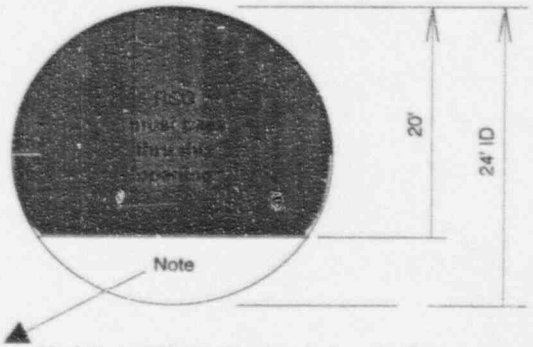
B6 AUXILIARY FEEDWATER NOZZLE DATA

CURRENT STEAM GENERATOR MODEL: E
AUXILIARY FEEDWATER NOZZLE LOCATION, elevation orientation

STEAM GENERATOR	ELEVATION	ORIENTATION OF VESSEL
A	See Part C	
B	See Part C	
C	See Part C	
D	See Part C	

B7 REPLACEMENT STEAM GENERATOR INSTALLATION REQUIREMENTS

MAXIMUM WEIGHT, tons	500 (dry) 894 (flooded)
MAXIMUM DIAMETER	See figure below
MAXIMUM HEIGHT ABOVE MAIN SUPPORT PADS	814.71"
LIFTING LUGS AND TRUNNIONS	(2) located 653.00" above bottom of main support pads



Four feet of floor depth has been assumed for transfer equipment and structure. Equipment hatch may be slightly out of round.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B8 EQUIPMENT SUPPORT AND RESTRAINT DRAWINGS

A. THE FOLLOWING DRAWINGS ARE PROVIDED BY THE PURCHASER TO INDICATE THE CURRENT STATION SUPPORTS AND RESTRAINTS CONFIGURATIONS.

STATION DRAWING NO.	DRAWING REVISION	DRAWING DESCRIPTION
3A01-0-S-0001	16	Steel Structural Standards - General Notes - Unit 1 & 2
2C26-9-S-1003	4	Steel - RCB - Base Plate Anchor Bolts and Details - Unit 1 & 2
1C01-9-S-1532	9	Structural - RCB - SG, RCP Vertical & PZR Lateral Support - Unit 1 & 2
1C01-9-S-1533	3	Structural - RCB - Internal - Lateral Support Embedment Plan - Unit 1 & 2
1C01-9-S-1534	1	Structural - RCB - Internal - Lateral Support Embedment Plan - Unit 1 & 2
1C01-9-S-1535	3	Structural - RCB - Internal - Steam Generator Supports, Sect. & Det. - Unit 1 & 2
1C01-9-S-1536	2	Structural - RCB - Internal - RCP Tie Rod Sup. Sect. & Det. - Unit 1 & 2
1C01-9-S-1537	3	Structural - RCB - Internal - Steam Gen. Supports Sect. & Det. - Unit 1 & 2
1C01-9-S-1538	3	Structural - RCB - Internal - Steam Gen. Supports Sect. & Det. - Unit 1 & 2
1C01-9-S-1549	2	Structural - RCB - Internal - Steam Gen. Supports Sect. & Det. - Unit 1 & 2
4C01-1-S-31009	6	Structural - RCB - Modified SG Upper Lateral Supt's - Sect's & Det's - Unit 1
4C01-1-S-31010	6	Structural - RCB - Modified SG Upper Lateral Supt's - Sect's & Det's - Unit 1
3C26-9-S-1517	6	Structural - RCB - Internal SS Liner Plate Framing - Unit 1 & 2

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B9 MAIN STEAM AND FEEDWATER NOZZLE LOADS

Informational Source: Westinghouse E2 Steam Generator Stress Report - Unit 1 - 14926-0120(1)-00019 CWN,
Unit 2 - 14926-0120(2)-00144-BWN
Westinghouse E-Spec for Model E Steam Generator - Unit 1 - 14926-0120(1)-00138 EWN,
Unit 2 - 14926-0120(2)-00132-EWN

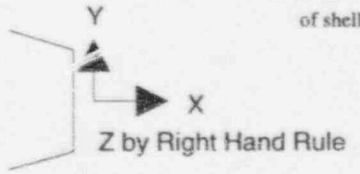
B9.1 MAIN STEAM NOZZLE:

LOADING	Fx (kips)	Fy (kips)	Fz (kips)	Mx (in-kips)	My (in-kips)	Mz (in-kips)
THERMAL	120	212	212	6900	18,244	18,244
PRESSURE	717	0	0	0	0	0
WEIGHT	25	34	34	500	556	556
SEISMIC OBE	105	192	192	7800	9000	9000
SEISMIC SSE	180	300	300	11,400	15,000	15,000
PIPE RUPTURE	1300	527	527	6850	16,870	16,870
PIPE RUPTURE (2)	2064	1460	1460	95,485	56,266	56,266

B9.2 MAIN FEEDWATER NOZZLE:

LOADING	Fx (kips)	Fy (kips)	Fz (kips)	Mx (in-kips)	My (in-kips)	Mz (in-kips)
THERMAL	10	50	25	1500	1909	3500
PRESSURE	175	0	0	0	0	0
WEIGHT	5	14	14	300	570	570
SEISMIC OBE	40	30	30	1100	1440	1440
SEISMIC SSE	77	70	70	1700	2000	2000
PIPE RUPTURE	35	26	26	1425	3581	3581
PIPE RUPTURE (2)	506	358	358	13,133	7739	7739

Notes: 1. All cuts are +/- unless otherwise indicated.
2. Nozzle safe-end need not be analyzed for this load case. Evaluation of adequacy of shell junction is required.



SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

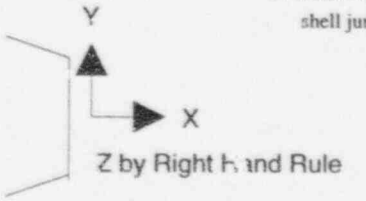
B9.3 PRIMARY INLET AND OUTLET NOZZLES:

LOADING (Note 1)	Fx (kips)	Fy (kips)	Fz (kips)	Mx (in-kips)	My (in-kips)	Mz (in-kips)
THERMAL, MAX	-25	+200	+75	+4500	+7200	+30,000
THERMAL,MIN	-250	0	-25	-4000	-4000	-600
PRESSURE, MAX	+1800	+50	+25	+1750	+2825	+1000
PRESSURE, MIN	+1400	-50	-50	-500	-2000	-3000
WEIGHT, MAX	+25	+1	+5	+100	+200	+755
WEIGHT, MIN	0	-25	-5	-125	-175	-225
SEISMIC OBE	400	475	150	1 500	13,500	13,500
SEISMIC SSE	550	625	200	20,500	18,000	18,600
PIPE RUPTURE (2)	2,750	2,100	1,400	27,500	35,000	41,000
PIPE RUPTURE (2)(3)	2,500	2,400	1,600	84,000	77,500	82,500

B9.4 AUXILIARY FEEDWATER NOZZLE

LOADING (Note 1)	Fx (lbs)	Fy (lbs)	Fz (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
THERMAL	10	35	10	225	225	225
DEADWEIGHT	3	3	3	25	30	30
SEISMIC (OBE)	10	5	5	125	175	175
SEISMIC (SSE)	15	10	10	200	250	250
PIPE RUPTURE	20	15	15	375	475	475
PIPE RUPTURE (3)	220	155	155	2,650	1,550	1,550

Notes: 1. All values are +/- unles otherwise indicated
2. Internal pressure loads are included. No not add pressure loads to this load case.
3. Nozzle Safe end need not be analyzed for this load case. Evaluation of adequacy of nozzle shell junction is required.



SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B9.5 MISCELLANEOUS NOZZLES

B9.5.1 2 INCH NOZZLE

LOADING	Fx (lbs)	Fy (lbs)	Fz (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
MAX THERMAL	500	90	660	4000	5000	3300
MIN THERMAL	500	150	860	4000	5000	3400
DEADWEIGHT	±25	±130	±20	±1500	±120	±850
SEISMIC (OBE)	±280	±250	±480	±5000	±8400	±4110
SEISMIC (SSE)	±500	±400	±700	±7000	±10,000	±5000

B9.5.2 1 INCH NOZZLE

LOADING	Fx (lbs)	Fy (lbs)	Fz (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
MAX THERMAL	50	115	40	750	1700	350
MIN THERMAL	60	105	40	1800	1700	500
DEADWEIGHT	±10	±70	±5	±360	±60	±360
SEISMIC (OBE)	±100	±150	±130	±1250	±1000	±2300
SEISMIC (SSE)	±170	±250	±300	±2500	±3200	±3000

B.5.3 0.75 INCH NOZZLE

LOADING	Fx (lbs)	Fy (lbs)	Fz (lbs)	Mx (in-lbs)	My (in-lbs)	Mz (in-lbs)
MAX THERMAL	±40	±75	±30	±500	±1000	±250
DEADWEIGHT	±5	±50	±5	±200	±50	±200
SEISMIC (OBE)	±50	±75	±100	±700	±800	±1500
SEISMIC (SSE)	±70	±150	±200	±1000	±1500	±2000

NOTES

1. Internal pressures should be considered in analytical models.
2. Thermal loads cycle on one side of zero.
3. In the case where the nozzle axes are vertical instead of horizontal, the deadweight loads Fx and Fy are to be interchanged.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B10 LOADING AT THE LOWER SUPPORTS AND UPPER RESTRAINT

Informational Source: Westinghouse E-Spec for Model E Steam Generator - Unit 1 - 14926-0120(1)-00138 EWN,
Unit 2 - 14926-0120(2)-00132-EWN

B10.1 LOADING AT THE LOWER SUPPORTS

LOADING	Fx (kips)	Fy (kips)	Fz (kips)	Mx (in-kips)	My (in-kips)	Mz (in-kips)
DEAD WEIGHT	50	325	50	500	25	500
THERMAL	50	400	50	2,000	50	2,000
PRESSURE	15	50	15	500	50	500
SEISMIC OBE	1,000	700	1,000	3,000	2,000	3,000
SEISMIC SSE	1,500	1,300	1,500	4,000	2,500	4,000
PIPE RUPTURE	3,200	2,500	2,000	7,000	8,000	7,000

B10.2 LOADING FOR THE UPPER RESTRAINT

LOADING	LOADS, kips
OBE	3000
SSE	4000
FAULTED CONDITION	10,000
EMERGENCY	None

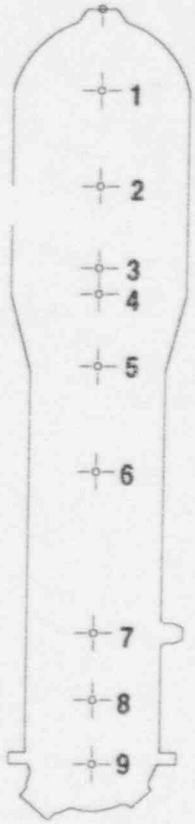
NOTES: Faulted conditions include SSE.
Loads may be applied to steam generator in any horizontal direction.

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B11 BENDING MOMENTS FOR STEAM GENERATOR SHELL

Informational Source: Westinghouse E-Spec for Model E Steam Generator - 14926-0120(1)-00137 BWN, 14926-0120(2)-00131-BWN

NODE	MOMENT (in-kips)	Applied at Centerline Elevation Above Main Support Pads (Inches)
1	270,000	747.37"
2	820,000	629.37"
3	1,300,000	551.37"
4	1,600,000	511.37"
5	2,000,000	415.24"
6	1,800,000	263.12"
7	1,200,000	111.0"
8	600,000	47.0"



SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

B12 DESIGN TRANSIENTS AND NUMBER OF OCCURRENCES

Normal (Level A) Transients	# of Occurrences
Plant Heatup	200
Plant Cooldown	200
Plant Loading	13,200
Plant Unloading	13,200
Small Step Load Increase	
15 - 25%	200
90 - 100%	2000
Small Step Load Decrease	
25 - 15%	200
100 - 90%	2000
Large Step Load Decrease	200
Feedwater Cycling at No Load	2000
Steady State Fluctuation:	
± 3°F, ± 25 psi	1.50E+05
± 0.5° F, ± 6 psi	3.00E+06
Plant Loading and Unloading between 0% and 15% power	1540 Loading 580 Unloading
Loop Out of Service	
Normal Pump Shutdown	80
Normal Pump Startup	70
Boron Concentration Equalization	26,400
Reactor Coolant Pump Startup/Shutdown	
Cold Conditions	500
Hot Conditions	1250
RCS Venting	
Affected Loops	800
Unaffected Loops	1600

SUPPLEMENT A
PLANT DATA SHEETS - INTERFACE INFORMATION - PART B

Upset (Level B) Transients	**# of Occurrences**
Loss of Load	80
Loss of Power	40
Partial Loss of Flow	80
Reactor Trip from Full Power	
Nominal	230
Inadvertent Heatup	160
Inadvertent Cooldown	10
Inadvertent RCS Depressurization	20
Inadvertent Startup of an Inactive Loop	10
Control Rod Drop	80
Operating Basis Earthquake (OBE)	20 (20 cycles / occurrence)
Excessive Feedwater Flow	30
Inadvertent Safety Injection Actuation	60
Bypass Line Tempering Valve Failure	40
Excessive Bypass Feedwater	40
Emergency (Level C) Transients	**# of Occurrences**
Small Loss of Coolant Accident	5
Small Steam Line Break	5
Complete Loss of Flow	5
Faulted (Level D) Transients	**# of Occurrences**
Reactor Coolant Pipe Break (Large LOCA)	N/A
Large Steam Line Break	1
Feedwater Line Break	1
Safe Shutdown Earthquake (SSE)	1 (10 cycles)
Locked Rotor	1
Rod Ejection	1
Simultaneous Feedline/Steamline Break	1
Steam Generator Tube Rupture	1
Test Conditions	
Primary Side Hydrostatic Test	10
Secondary Side Hydrostatic Test	10
Primary Side Leakage Test	200
Secondary Side Leakage Test	80
Tube Leak Test	
Secondary Side Pressure	
200	400
400	200
600	120
840	80

SUPPLEMENT A
PLANT DATA SHEETS - NOZZLE TABLE - PART C

Drawing ID# (Note 1)	Nozzle	Qty	Nozzle Body Material	Safe End Material	Terminal Point Location (Note 2,3,4,5)	Safe End Length Relative to Terminal Point (Note x) Inboard	Outboard	Connecting Piping Material	Connection ID	Connection OD	Elevation wrt Bottom of Support Ring	Azimuth as Viewed From Bottom CCW = + from orig fdw nozzle location Right Hand	Left Hand
1a 1b	Primary Inlet / Outlet	1/1	Seller to Recommend	Seller to Recommend	X =±32.989" Y = ±44.588" H = -69.145"	7.8" min less 1152 thickness	2" min.		31.20" ±0.01"	38.44" ±0.12"	-48.84" ±0.38"	Inlet: +143.5° ±10' Outlet: +36.5° ±10'	Inlet: -143.5° ±10' Outlet: -36.5° ±10'
14	Main Steam	1	Seller to Recommend	Seller to Recommend	X = Y = 0" H = 814.71"	2" min.	4" min.		29.375" +0", -0.01"	32" +0.06", -0"	814.71" ±0.75"	None	Same as RH
10	Main Feedwater	1	Seller to Recommend	Seller to Recommend	R = 109.875"	N/A	0.25" min.		14.464" +0", -0.01"	16" +0.06", -0"	TBD" ±0.50"	TBD° ±10'	Same as RH
17	Auxiliary Feedwater	1	Seller to Recommend	Seller to Recommend	R = 100.125"	0.5" Min.	0.25" min.		5.506" +0", -0.01"	6.75" +0.06", -0"	529.12" ±0.50"	+17° ±10'	Same as RH
6a 6b	Secondary Side Blowdown	2	Seller to Recommend	Seller to Recommend	R = 72.1875"	1.0" min.	0" min. 0.5" max.		(Note 7)	(Note 7)	38.59" ±0.25"	Seller to Recommend	Same as RH
5	Primary Head Drain	0	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Same as RH
7	Shell Drain	1	Seller to Recommend	Seller to Recommend							top of tubesheet	-15° ±30'	+15° ±30'
11	Shell Sample	1	Seller to Recommend	Seller to Recommend	R = 92.375"	1.5" min.	0" min.		0.75" ± 0.05" (Note 5)	2" min.	TBD" ±0.38"	180° ±30'	Same as RH
9a	Upper WR Level Tap	1	Seller to Recommend	Seller to Recommend	R = 92.375"	1.5" min.	0" min.		0.75" ± 0.05" (Note 5)	2" min.	646" ±0.38"	60° ±60'	Same as RH
9b	Lower WR Level Tap	1	Seller to Recommend	Seller to Recommend	R = 72.1875"	1.5" min.	0" min.		0.75" ± 0.05" (Note 5)	2" min.	49" ±0.38"	60° ±60'	Same as RH
12e 12f 12g 12h	Upper NR Level Tap	4	Seller to Recommend	Seller to Recommend	R = 92.375"	1.5" min.	0" min.		0.75" ± 0.05" (Note 5)	2" min.	646" ±0.38"	12e: 30° ±60' 12f: 0° ±60' 12g: -45° ±60' 12h: TBD° ±60'	Same as RH
12a 12b 12c 12d	Lower NR Level Tap	4	Seller to Recommend	Seller to Recommend	R = 92.375"	1.5" min.	0" min.		0.75" ± 0.05" (Note 5)	2" min.	467" ±0.38"	12a: 30° ±60' 12b: 0° ±60' 12c: -45° ±60' 12d: 65° ±60'	Same as RH
23	Steam Dome Tap*	1	Seller to Recommend	Seller to Recommend	Seller to Recominend	1.5" min.	0" min.	n/a	0.75" ± 0.05" (Note 5)	2" min.	Seller to Recommend	Seller to Recommend	Same as RH

NOTES:

1. Drawing ID # refers to the general arrangement drawing of the existing steam generator.
2. Deleted.
3. RSGs are to be supported such that the bottom of SG support pad/ring lies 37' 11" nominally above STP zero (0') elevation (See B4.2)
4. Unless otherwise stated, dimensions are nominal with maximum tolerance of ±0.25".
5. ID refers to thru wall bore diameter. End connection shall be a socket counterbored for 0.50" min. engagement of a 0.75" NPS pipe. Boss-type connections are prohibited.
6. Primary head drains are prohibited.
7. Blowdown nozzle shall be nominal 2.5 inches.

* These connections are to be capped or plugged and qualified for service with caps or plugs in place.

SUPPLEMENT B
DESIGN PARAMETER DATA SHEET - Note 1

PARAMETER	PROPOSED DESIGN VALUE/DESCRIPTION (Note 2)	CLOSEST EMPIRICAL EXPERIENCE site parameter value/description, plant name where implemented and historical experience with service related to design parameter
TUBING		
O.D.	0.688"	Westinghouse Model F & Delta 75 SG
Wall Thickness	0.040"	Westinghouse Model F & Delta 75 SG
Material	SB 163 Alloy 690	21 SGs in operation
S/N Criterion	15-1	21 SGs in operation
Final O.D. Defect Depth Criterion	0.002 Reference	21 SGs in operation
Primary Tubing Supplier	Sandvik	21 SGs in operation
Tube Pitch	0.980"	Westinghouse Model F & Delta 75 SG
Joint Configuration Seal Weld Method/Configuration Expansion Method Expansion pressure Multiple stage expansion required? and scope Max residual stress in joint transition zone(s) Max crevice depth from top of tubesheet	 Flush - Autogenious Weld Full Depth Hydraulic 36,000 psi Urethane Tack & Full Depth <20 ksi tube O.D. 0.25"	Westinghouse Delta 75 and 37 other RSGs
TUBE BUNDLE		
Overall height above tubesheet	440"	Westinghouse Delta 75 SG
Number of tubes	7585	Westinghouse Delta 75 SG
Heat Transfer surface area (O.D. of tubes)	94550 ft^2	Westinghouse Delta 75 SG
Method of Tube Support Alignment	Laser Alignment	Westinghouse Delta 75 SG
Longest span between straight tube supports	40"	Westinghouse Delta 75 SG
Longest span between supports in U-Bend area	Approximately 30"	Westinghouse Delta 75 SG
Shortest radius U-bend	3.25"	Westinghouse Delta 75 SG
TUBE SUPPORTS		
Type of Straight Tube Supports	Broached stainless steel tube support plates	Westinghouse Delta 75 and 37 other RSGs
Type of U-Bend Supports	405 stainless steel bars	Westinghouse Delta 75 and 37 other RSGs
Method of U-Bend Support Installation	Installed after tube assembly	Westinghouse Delta 75 and 37 other RSGs
Support Material with quoted corrosion resistance experience	405 stainless steel	Westinghouse Delta 75 and 37 other RSGs
Profile of Tube/Support Non-Contact Area with appropriate projected flow velocities	TBD	

SUPPLEMENT B
DESIGN PARAMETER DATA SHEET - Note 1

Maximum axial contact length with any tube	1.08"	Westinghouse Delta 75 and 37 other RSGs
TUBESHEET		
Thickness without clad	25.12" minimum	
Minimum ligament thickness after drilling	0.241"	Westinghouse Delta 75 SG
Hole and location nominal dimensions and tolerances (including perpendicularity)	0.698 +.003/-.002	Westinghouse Delta 75 SG
Tubesheet flatness and face parallel tolerances	0.010/0.005 and 0.015	Westinghouse Delta 75 SG
Material	SA508 Class 3a	Westinghouse Delta 75 SG
Sludge Lance Capabilities	six 6" handholes at tubesheet	Westinghouse Delta 75 SG
FEEDWATER DISTRIBUTION		
Preheater General Description/Configuration/Location Type of flow - axial vs cross Inspection/Repair capabilities	Not Applicable	
Feedring General Description/Configuration/Location Header Construction/Materials Nozzle Construction/Materials Inspection/Repair Capabilities	 Elevated FW Ring with Spray Tubes SA 335 Gr P11 SA 508 Cl 3a Accessible for Repair	 Westinghouse Delta 75 SG Westinghouse Delta 75 SG Westinghouse Delta 75 SG Westinghouse Delta 75 SG
Auxiliary Feedwater General description/Configuration/Location Header Construction/Materials Nozzle Construction/Materials Inspection/Repair Capabilities	 6" Nozzle/Upper Shell Alloy 690 SA 508 Cl 3a Accessible for Repair	 Westinghouse Delta 75 SG Westinghouse Delta 75 SG Westinghouse Delta 75 SG Westinghouse Delta 75 SG
MOISTURE SEPARATION EQUIPMENT		
General Description/Configuration	TBD	
Materials	TBD	
MCO from Primary Separators exit	TBD	
MCO from Secondary Separators exit (if applicable)	TBD	
Moisture Carryunder	TBD	
BLOWDOWN / RECIRCULATION		
General Description/Configuration	2.5" Internal Pipe	Westinghouse Delta 75 SG
Materials	Alloy 690	Westinghouse Delta 75 SG

SUPPLEMENT B
DESIGN PARAMETER DATA SHEET - Note 1

Capacity	1% Continuous/6% Intermittent	Westinghouse Delta 75 SG
Plant modifications required to accommodate	Relocation of Blowdown Pipe	Westinghouse Delta 75 SG
Projected frequency of required sludge lance	TBD	
GENERAL ASSEMBLY		
RSG dry weight/C.G.	480 tons/365"	Westinghouse Delta 75 SG
Max diametric projection/location	115" Radial - FW Nozzle	Westinghouse Delta 75 SG
Shell Material	SA 533 Type B Cl2	Shearon Harris Delta 75 SG
Description of external/internal accesses including sizes, locations and weights of covers	TBD	Westinghouse Delta 75 SG
THERMAL / HYDRAULIC PARAMETERS		
Secondary Side Volumetric & Mass Inventory at 100% Power	6929 ft^3/167,730 lb	Westinghouse Delta 75 SG
Primary Side Volumetric & Mass Inventory at 100% Power	1518 ft^3/66,696 lb	Westinghouse Delta 75 SG
Overall primary Side dP	31.6 psi	Westinghouse Delta 75 SG
Overall Secondary Side dP	20.7 psi	Westinghouse Delta 75 SG
Circulation Ratio	3.89	Westinghouse Delta 75 SG
Projected T_{av} at 100% power in new and clean condition	617.3°F (Best estimate for 1040 steam pressure)	Westinghouse Delta 75 SG
Projected plugging margin in % at new and clean conditions	10%	Westinghouse Delta 75 SG
Projected Primary Flow per RSG at new and clean conditions	105,900	Westinghouse Delta 75 SG
Projected Plugging margin and T after 40 years service	10% - 619.1°F	Westinghouse Delta 75 SG
Maximum crossflow velocities at critical tube locations	TBD	
Water level range by elevation at 100% power operation	TBD	
U (overall heat transfer coefficient)	TBD	

Note 1 - All information provided in Supplement B is for information only. For design purposes, Seller should verify and utilize the information from existing controlled STP documents such as the original steam generator design specification, stress reports, piping analysis, UFSAR, SER, etc.

Note 2 - Proposed Design Value/ Description represents preliminary design information and may be superseded by Purchaser approved design documents or by mutual agreement between Seller and Purchaser. This data shall be updated following completion of the Unit 1 replacement steam generators.

Preface:

The purpose of this instruction document is to describe to the contractor standard requirements for creating and submitting CAD drawings to Houston Lighting and Power Company, South Texas Project Electric Generating Station (STP).

CAD drawings shall be provided and maintained to the standard sheet sizes provided in the seed files, i.e., A through E sizes. The Seller shall scale drawings into standard Seed file borders as supplied by STP's Design Engineering Departments CADD/Design Group . Drawings produced to scale shall be in provided in 1/8th inch increments. When pertinent information is located or transferred to another drawing, the drawing coordinate system shall be used.

The final approved drawing products shall be provided in vector format, which are 100% compatible with Intergraph's MicroStation product software, version 5.0 or subsequent versions utilized by STP.

Base Setup for CAD Drawing Files:

- Global origin for all drawings shall be 1000, 1000
- Intergraph MicroStation 32 working units shall be set as follows:
- Unit Names - Master Units: 1 Foot (')
  Sub Units: 1 Inch (")
- Resolution - 12" Per Foot ("Per')
  8000 Positional Units Per Inch (POS Units Per ")

Design Drawing Format:

- **Lettering**

  General lettering shall be 1/8" high x 1/8" wide (TH = .125, TW = .125), font Ø and uppercase, unless otherwise instructed by STP's CADD / Design Group.
  Fractions shall be stacked.
  Section and detail callouts, etc., shall be 3/16" high (1/8" in the bubble), font Ø and uppercase. Use numerical callouts for drawing details, and alpha character callouts for section details.

- **Line Weights**

Line Type	Line Code	Line Weight
Main Process	Ø	4
Secondary	Ø	2
Dimension	Ø	1
Center	7	1
Dotted	2 or 3	1
Phantom	6	1
Match	6	4

NOTE: Weight Ø shall not be used for any entity on STP CAD Drawings.

- **Levels**

  Text shall be on Level 2, except for revision numbers, and revision triangles.
  Revision triangles, numbers and clouds and any hold information shall be on Level 62
  All other line work shall be on Level 1, unless otherwise required by STP.

- **Colors**

  Currently, STP is not mandating specific color, with the exception of red for revision and hold information.

- **Miscellaneous**

  Arrowheads, and section view markers etc., shall be solid shapes, with fill if required.

- **Key, Non-Key Symbols, Priority No., Document No., and CADD Logo**

  The CADD Logo which is generally attached to an applicable drawing Reference file. Key or Non-Key symbols, and the drawing Priority number shall be placed on the lower right corner of the drawing outside the border immediately to the left of the CADD Logo. The Document number is placed to the right of the CADD Logo (See Attachment A).

  CADD Logo - To be placed on all STP CADD Drawings.

  Key Symbol - To be placed on all STP Design Drawings such as P&ID's, Single Line Diagrams, Logic Diagrams, Elementary Diagrams and Lighting Drawings. Vendor equipment drawings are exempt from this requirement.

  Non-Key Symbols - Non-Key symbols shall be placed on all other STP Design Drawings. Vendor equipment Drawings are exempt from this requirement.

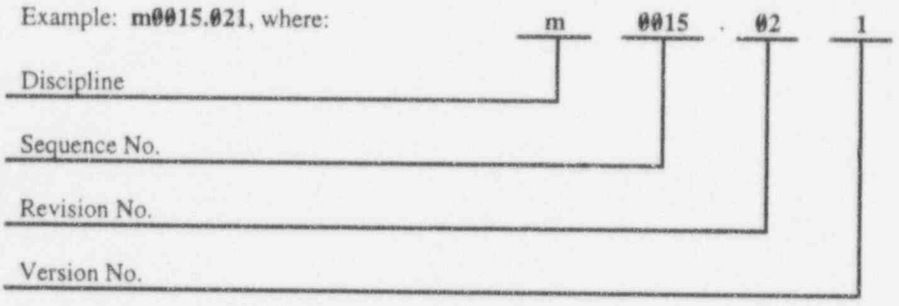
  Key Drawings are Priority 1, Non-Key Drawings are Priority 3, and Vendor Drawings are Priority 2.

- **Document Control File Numbers**

  Document Control file numbers shall be placed on each new CADD drawing on the lower right hand corner of the drawing immediately to the right of the CADD Logo. The document number for Design drawings is **D0070928**. The document number for Vendor equipment drawings is **D07090702**.

File Number Convention for Both Design and Vendor equipment Drawings:

Each drawing submittal to HL&P shall have the drawing revision and version included in the file number as follows.



Note: Zero will not be used for CADD file versions. Valid versions are 1-9.

In the example the first five digits indicate the CAD file number provided by HL&P. The next three digits preceded by period indicate the file extension number. The first alpha character **m** represents the Mechanical Discipline, (Vendor Equipment Drawings are identified with two lower case alpha characters **vt**). The first two digits of the file extension number indicate the drawing revision and the third digit indicates the version update of the file. For example the file number above, the file extension indicates the drawing is at revision **02**, and it is at version **1**. If the drawing is resubmitted as revision 02, and changes have been made to change the drawing while it is still at revision **02**, the file number extension is to be revised as follows **.022**. If the drawing is resubmitted as revision **3**, then the file number extension will be revised to **.031**which indicates the drawing is being

issued as revision **3**, version **1**. A new drawing will start out as **m0015.001** revision **0**, version **1**. See Attachment A for proper placement of the file number.

Quality Requirement:

Symbology, line weights and styles, text fonts and sizes shall conform to STP standards. Any request deviations from these standard are to be discussed with DED CADD/Design Group for acceptance.

If the drawings do not meet standards, the drawings will be sent back for rework to be performed by the Seller at no additional cost to STP.

Deliverables to Seller:

The STP DED CADD System Administrator will provide a set 8mm tapes containing cells, Reference and Seed files for "A" through "E" size drawings and standards as required. Reference and Seed files will contain the drawing border, microfilm target arrows and the CADD logo.
Standard Reference and Seed file names with sheet sizes are as follows:

Vendor Equipment Drawing Seed Files:

```
vtasize.dgn ----- "A" =  8½" X 11"
vtbsize.dgn ----- "B" =  11" X 17"
vtcsize.dgn ----- "C" =  17" X 22"
vtdsize.dgn ----- "D" =  22" X 34"
vtesize.dgn ----- "E" =  34" X 44"
```

Design Drawing Reference Files:

```
adwg.dgn ------- "A" = 8½" X 11"
bdwg.dgn --------"B" = 11" X 17"
cdwg.dgn --------"C" = 17" X 22"
ddwg.dgn --------"D" = 22" X 34"
edwg.dgn  -------"E" = 34" X 44"
```

Deliverables from Seller:

Prior to the submittal of approved drawings for issue, the Seller needs to contact the CADD System Administrator for file number assignment. Contact can be made by FAX through the STP LAN system (512) 972-8775 to Steve Antonio or use CC Mail if Seller has a connection with STP. Information on the FAX needs to include Drawing Nos, Revisions, Titles, and STP's Purchase Order No.

After the Seller has received final approval drawing(s) from engineering, the Seller shall furnish two sets of CAD design files for each batch of finished drawings to STP DED CADD/Design Group.

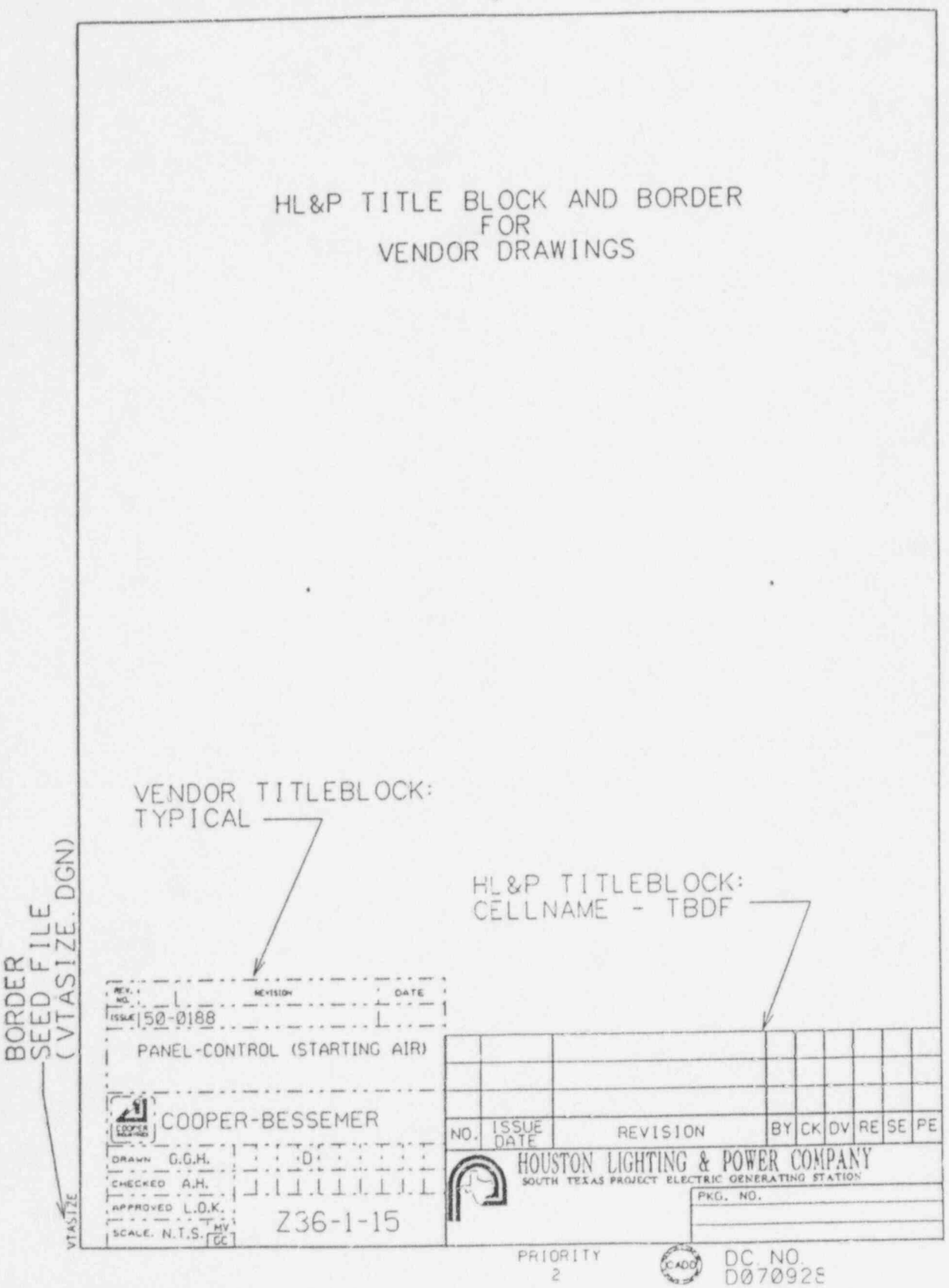
The two sets of design files may be compressed and shall be submitted to the STP DED CADD/Design Group on two (2) separate 8mm Sony QG112MA4 or equivalent data grade tapes (UNIX format 2.3 gigabyte). Each set of tapes shall be affixed with a permanent label clearly depicting the following:

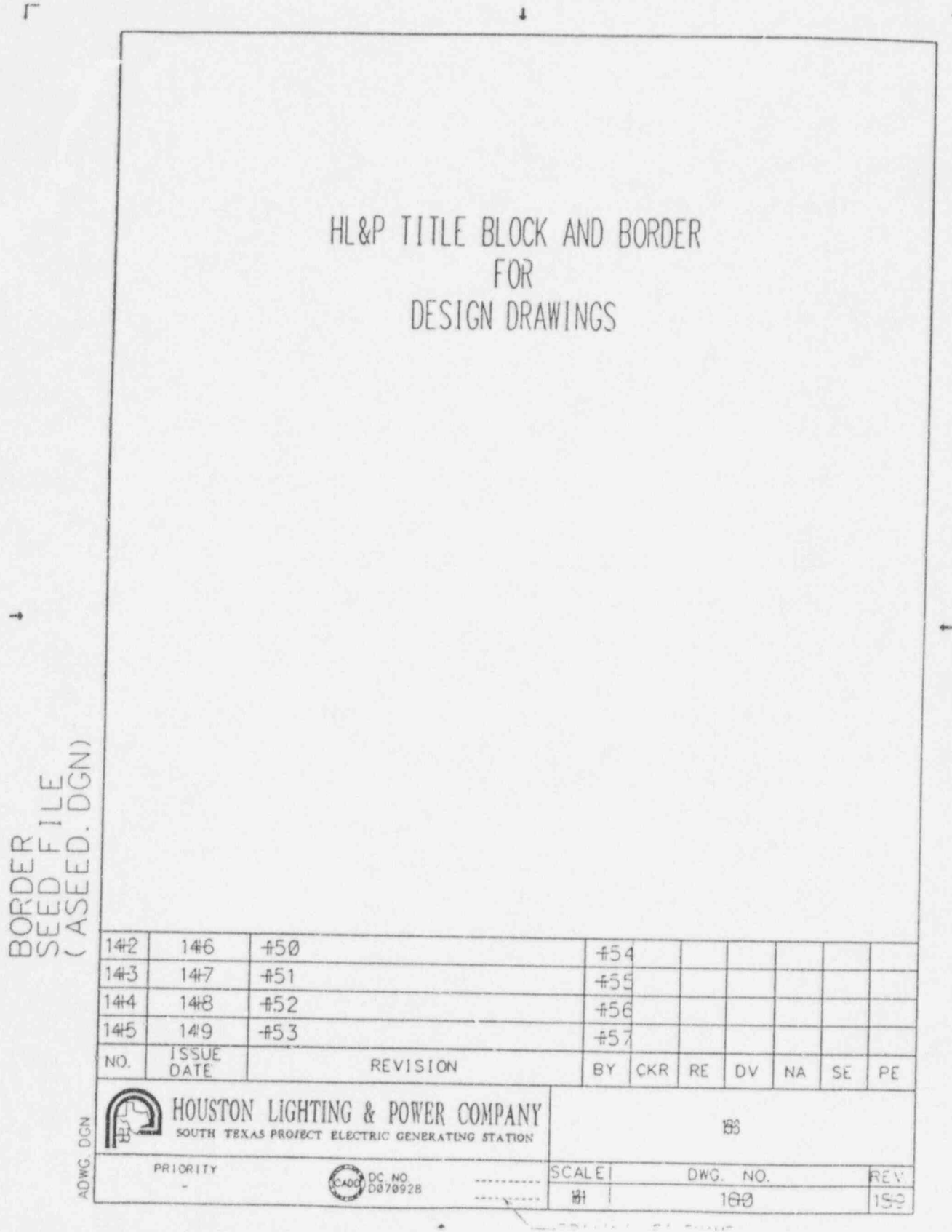
STP purchase order number
Company or Corporation name
The date tape was submitted
A sequential tape number being released per submittal
The UNIX scpio command used to perform the back up

Each cassette is accompanied with a directory printout of all file numbers on the tape. Seller shall provide (1) hardcopy black and white plot for each new CAD drawing completed to the STP DED CADD/Design Group.

Attachment - A

HL&P Title Block and Border Arrangements for Vendor & Design Drawings


HL&P TITLE BLOCK AND BORDER
FOR
VENDOR DRAWINGS
VENDOR TITLEBLOCK:
TYPICAL
HL&P TITLEBLOCK:
CELLNAME - TBDF
BORDER
SEED FILE
(VTASIZE.DGN)
REV. NO.
REVISION
DATE
ISSUE
50-0188
PANEL-CONTROL (STARTING AIR)
COOPER-BESSEMER
DRAWN G.G.H.
CHECKED A.H.
APPROVED L.O.K.
SCALE N.T.S.
Z36-1-15
VTASIZE
NO.
ISSUE DATE
REVISION
BY
CK
DV
RE
SE
PE
HOUSTON LIGHTING & POWER COMPANY
SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION
PKG. NO.
PRIORITY
2
DC NO.
D07092E


HL&P TITLE BLOCK AND BORDER
FOR
DESIGN DRAWINGS
BORDER SEED FILE (ASEED.DGN)
142 146 #50 #54
143 147 #51 #55
144 148 #52 #56
145 149 #53 #57
NO. ISSUE DATE REVISION BY CKR RE DV NA SE PE
HOUSTON LIGHTING & POWER COMPANY
SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION
ADWG.DGN
PRIORITY -
CADD DC NO. D070928
SCALE 1
DWG. NO. 100
REV 15

LICENSING SUPPORT PROGRAM PLAN

Westinghouse will perform the following safety analysis and licensing work, and supporting engineering efforts to support the implementation of the replacement steam generators.

- SAFETY ANALYSIS

Perform engineering analysis and evaluations to determine any potential effects of the replacement steam generators on the South Texas plant technical specification and licensing basis accident analyses including: Loss of Coolant Accident (LOCA) analyses, LOCA hydraulic forces, non-LOCA transient analyses, containment mass and energy releases, steam generator tube rupture (SGTR) analysis and associated radiological consequences.

- LICENSING

Perform an integrated safety evaluation based on the safety analyses and engineering work described above to demonstrate that the replacement steam generators will not adversely affect the safe operation of the South Texas plant. To support STP efforts to obtain approval from the NRC for implementation of the replacement steam generators, this evaluation will demonstrate safe plant operation in accordance with the Nuclear Regulatory Commission (NRC) screening criteria documented in the U.S. Code of Federal Regulations, Title 10, Parts 50.59 (10CFR50.59) and 50.92 (10CFR50.92). Both sets of criteria will be explicitly addressed and documented in separate sections of an integrated safety evaluation report. This report will be accompanied by Westinghouse Safety Evaluation Checklists (SECLs) associated with each set of criteria.

- ENGINEERING SUPPORT

Perform engineering analyses and evaluations to determine that the structural integrity and performance of the following systems and components, and the continued applicability of plant performance and safeguards data, are not adversely affected by the replacement steam generators: Reactor Coolant System (RCS) primary loop system and equipment supports, reactor pressure vessel and internals system and components, plant primary and secondary system performance data, and secondary side transient performance data for use in steam generator design analysis.

RSG SAFETY AND ENGINEERING SCOPE OF SUPPLY

- LOSS OF COOLANT ACCIDENT ANALYSIS (LOCA)

This effort will be initiated by assembling all pertinent replacement steam generator data and associated plant operating conditions data. These data will establish the basis for the various LOCA analyses described below.

- Large Break LOCA

Westinghouse will review the large break LOCA (LBLOCA) analysis which forms the licensing basis for the South Texas plant and will conservatively estimate the effects of the Model replacement steam generators. In particular, previous sensitivity studies will be reviewed to determine the effect of the increased replacement steam generator heat transfer area on the Post-LBLOCA behavior of the Reactor Coolant System.

- Small Break LOCA

Westinghouse will review the small break LOCA (SBLOCA) analysis which forms the licensing basis for the South Texas plant and will conservatively estimate the effects of the Replacement Steam Generators. NOTRUMP will be used to perform sensitivity cases, and the results of these cases will provide a technical basis describing the effects of the replacement steam generators on the SBLOCA analysis.

- Post-LOCA Long-Term Core Cooling Subcriticality Requirements

Westinghouse will perform an evaluation to establish the effects of the replacement steam generators on the licensing basis post-LOCA Long Term Cooling Subcriticality calculations. This evaluation will include calculating the effect of the change in primary system volume on the Post-LOCA Long-Term Cooling Subcriticality calculations. This evaluation will include calculating the effect of the change in primary system volume on post-LOCA boron concentration, and will consider other effects as appropriate.

- LOCA HYDRAULIC FORCING FUNCTIONS

Westinghouse will evaluate the steam generator LOCA hydraulic forcing functions, and perform evaluations of the reactor vessel and primary loop forcing functions to demonstrate continued and conservatively applicability of these data. The results of this evaluation will be used to demonstrate that the RSGs do not adversely affect LOCA (and seismic) loads on these systems and components (i.e., the reactor vessel), the reactor coolant loop piping, the reactor coolant pumps and the pressurizer surge line piping).

- STEAM GENERATOR TUBE RUPTURE AND RADIOLOGICAL CONSEQUENCES

Westinghouse will reanalysis the SGTR event using the Final Safety Analysis Report (FSAR) methodology to determine the potential effects of the replacement steam generators on break flow and steam releases, and the associated radiological consequences.

- LOCA AND MAIN STEAMLINE BREAK MASS/ENERGY RELEASE RATES

- Long-Term Containment Integrity Analysis

Westinghouse will calculate the mass and energy release rates calculation input data associated with the following scenarios:

-- Short-term and long-term LOCA mass and energy releases to containment.

-- Sort-term and long term main steamline break mass and energy releases to containment.

-- Outside containment (steam tunnel) main steamline break mass and energy release rates.

-- Steam Generator blowdown line break mass and energy release rates.

The mass and energy release rates will be provided to HL&P for their evaluation of the containment and outside containment pressure and temperature response.

Westinghouse will evaluate the NON-LOCA transient analyses potentially affected by the replacement steam generators. These include events sensitive to secondary side parameters such as the steam generator volumes and masses, water level trip setpoints, heat transfer characteristics, and operating conditions (i.e., steam pressure and temperature).

- MECHANICAL EQUIPMENT AND SYSTEMS

- Design Transients

Westinghouse will confirm that the design basis transients are not affected by the replacement steam generators based on final system performance conditions.

- Reactor Pressure Vessel and Internals System and Components

Westinghouse will review the current stress and fatigue analyses for various reactor and internals components to confirm that the assumptions and inputs to those analyses are consistent with the performance of the plant based on implementation of the replacement steam generators. This is necessary to ensure that the replacement steam generators do not adversely affect the basis and/or conclusions of the current analyses.

- Primary Loop Piping and Support System

Westinghouse will review the primary loop system structural analysis due to changes in the mechanical characteristics of the system incurred by the changes to the steam generator weight and center of gravity.

Computer Codes Pre-approved by HL&P for use by the Seller's Pensacola Division:

1. ATHOS

   A computer code for three dimensional, steady-state and transient two-phase analysis in a PWR steam generator.

2. ADINA and ADINA-F

   ADINA is a structural finite element program which is capable of analyzing large displacement problems. ADINA-F is a finite element program used for the solution of incompressible fluid flows.

3. CFD-TWOPHASE

   CFD-TWOPHASE is an integrated Computational Fluid Dynamics program that provides a unique capability for the simulation of two-phase flows in complex geometries.

4. GENF

   The GENF computer program evaluates the thermal/hydraulic performance of non-preheat type steam generators. Given the geometric parameters, primary side operating conditions and feedwater temperature, it computes the steam pressure, circulation ratio, primary and secondary side pressure drops and secondary coolant mass inventory.

5. FLOVIB

   FLOVIB is a program with the capability to perform flow-induced vibration calculations for three dimensional structures. The program is actually a compilation of four individual computer programs: SHAKE, SHAPE, TURVIB and SUPER. SHAKE calculates natural frequencies and mode shapes of the structure. SHAPE is a post-processing routine for SHAKE and produces the mode shape plots. TURVIB performs flow-induced vibration calculations for tube arrays. SUPER computes modal displacements, forces, moments and stresses on structure due to vibration.

6. FRMECH

   FRMECH was created to perform nonductile failure evaluations per Section III of the ASME Code. The program calculates the critical crack size (a_c) or the stress intensity factor (K_I) by using the following fracture mechanics analysis techniques.

   1. Appendix G of the ASME Code
   2. Buchalet
   3. WRCB-175
   4. McGowan

7. TRANFLOW

   TRANFLOW solves the mass, energy and momentum conservation equations for transient thermal/hydraulic phenomena using a fully implicit backward differencing technique.

8. WECAN/Plus

WECAN/Plus is a combination of the general purpose finite element code WECAN and the pre- and postprocessing program FIGURESII.

The WECAN computer program can be used to solve a large variety of structural analysis problems. It has the capability to perform static elastic and inelastic analysis, steady state and transient heat conduction analysis, steady state hydraulic analysis, standard and reduced modal analysis, harmonic response analysis and transient dynamic analysis.

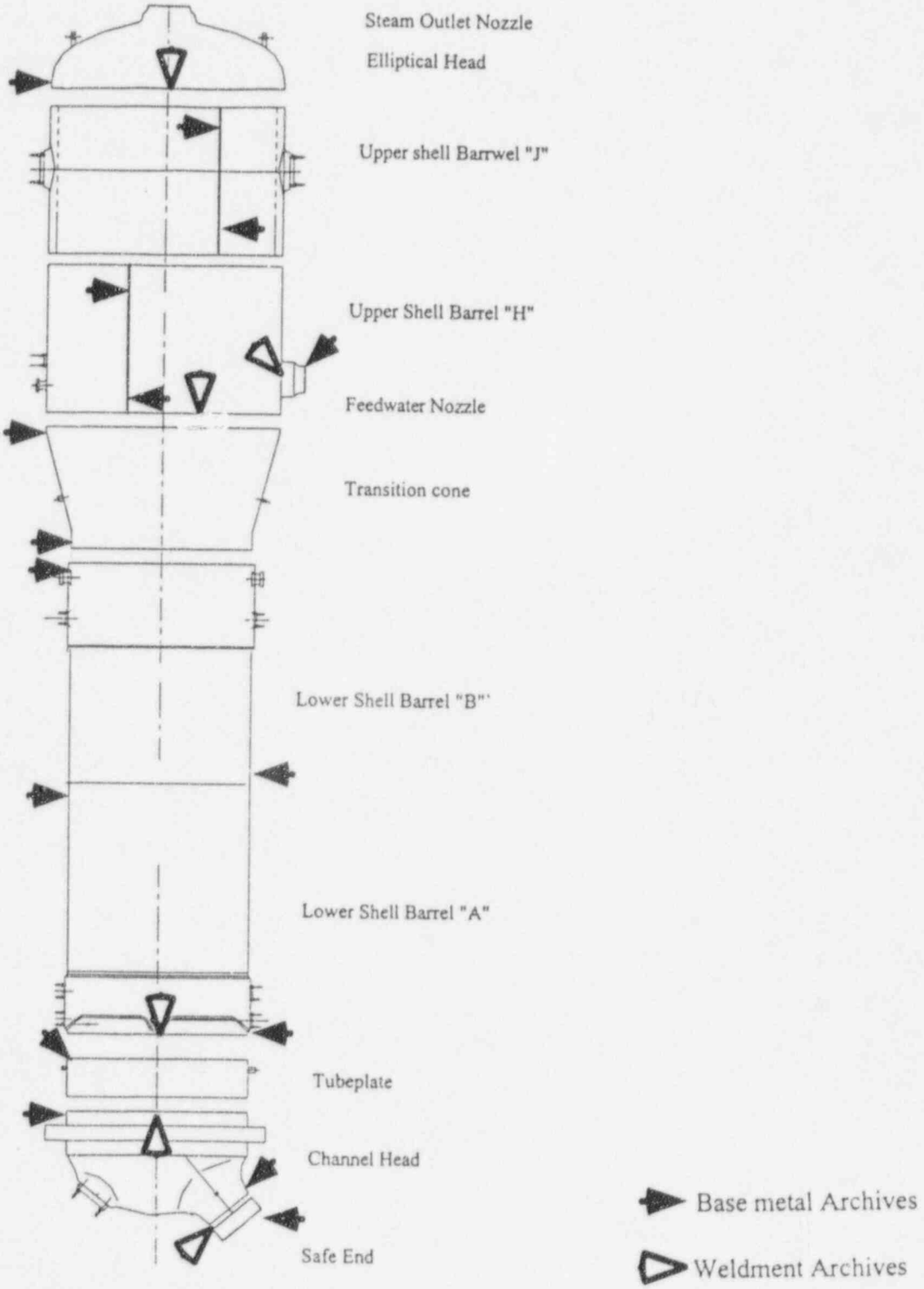
The FIGURESII pre- and postprocessing program aids users in the rapid generation of finite element models and in the visual interpretation of the finite element analysis results.

9. WECEVAL

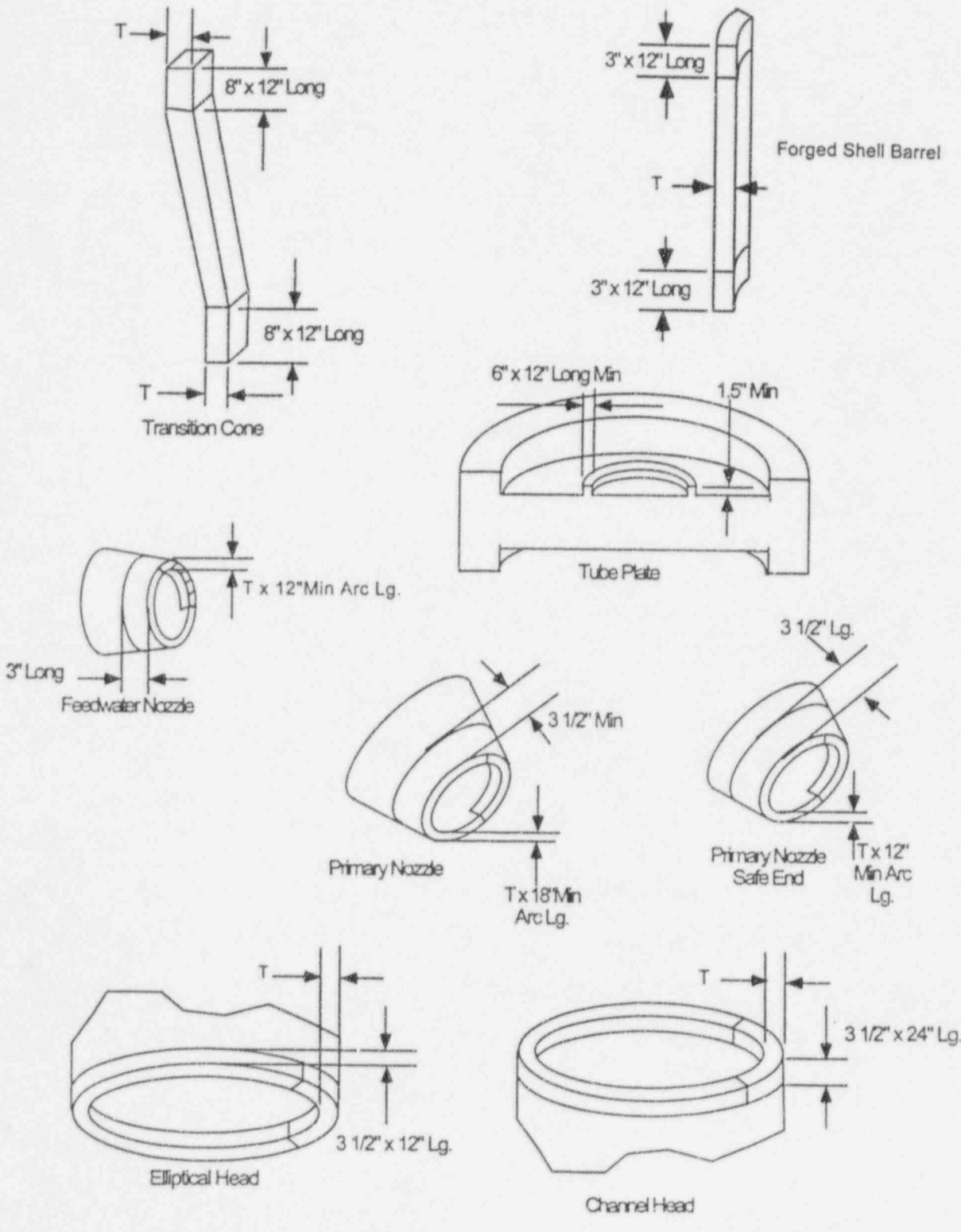
WECEVAL is a computer code that was written to perform ASME Subsection NB stress calculations. The code was written to use the stress files generated by many of the WECAN elements. The evaluations performed are: Primary Stress, Primary plus Secondary Stress Range and Fatigue. WECEVAL generates the stress state at each point by the ratio-superposition technique.

NOTE: Material identified elsewhere in this specification for spares and mockup is NOT archive material, and shall be provided in addition to the material identified below.

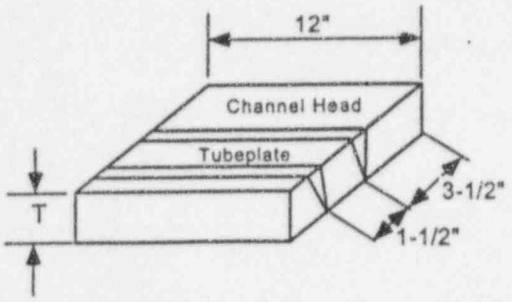
Archive Sample Locations

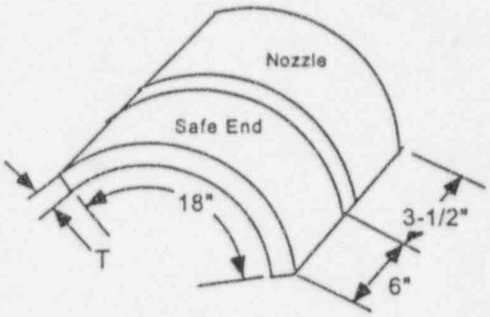


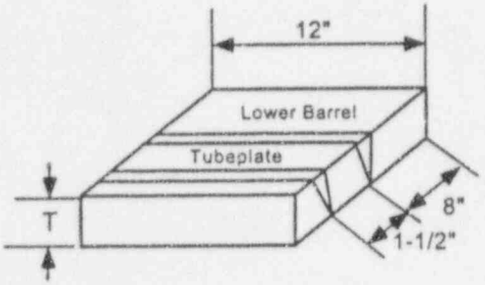
Base Metal Archive Samples

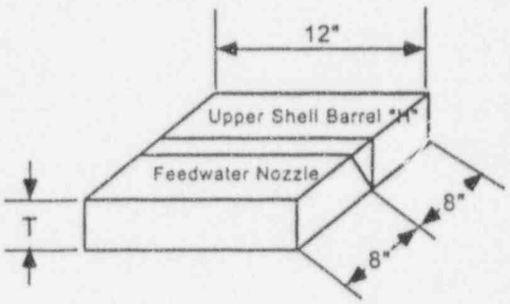


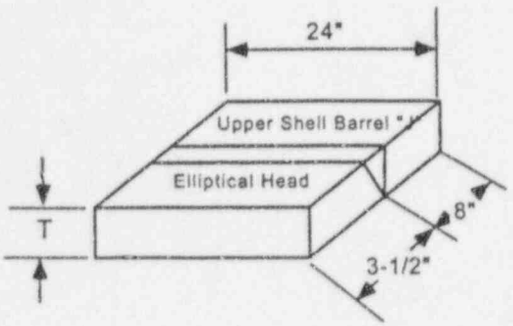
Weldment Archive Samples

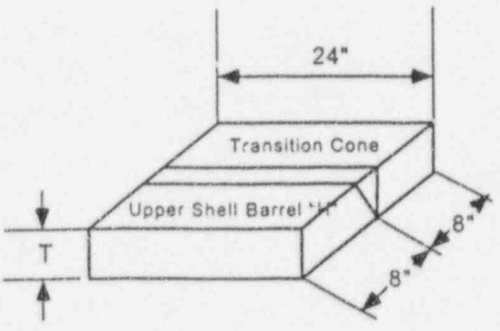












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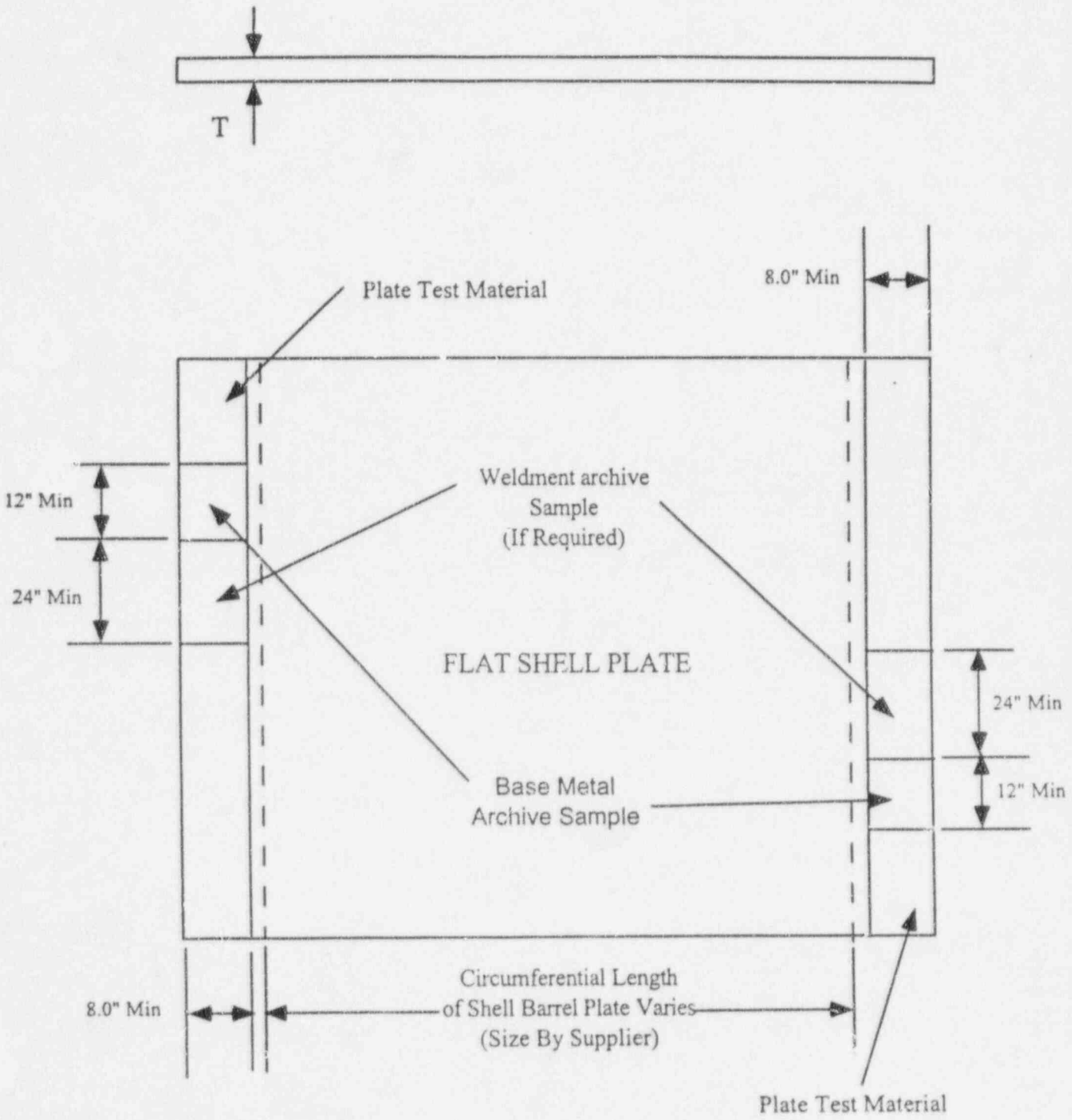

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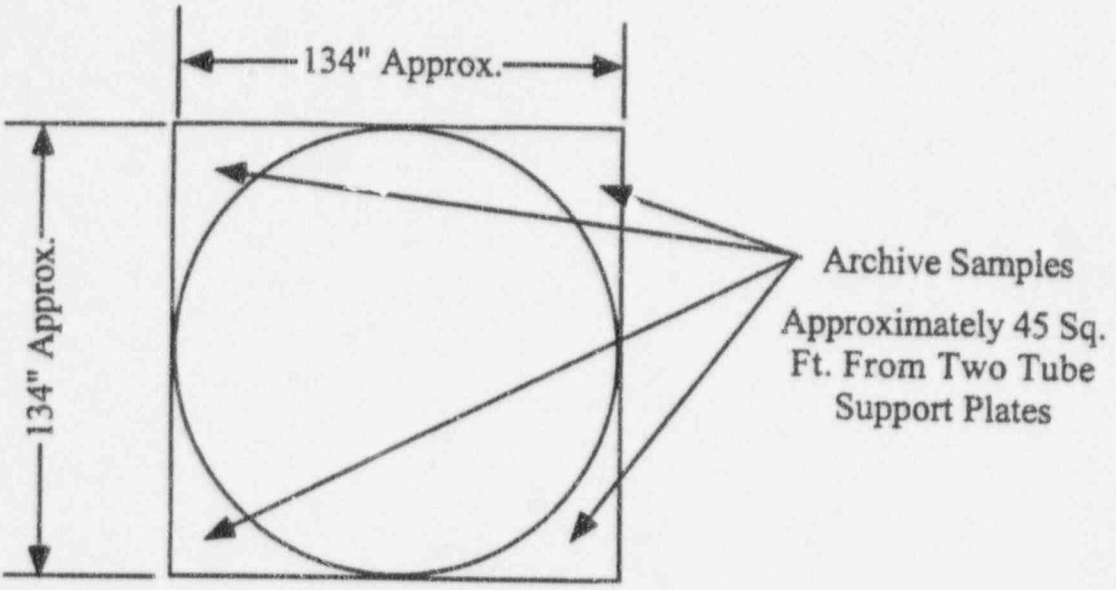
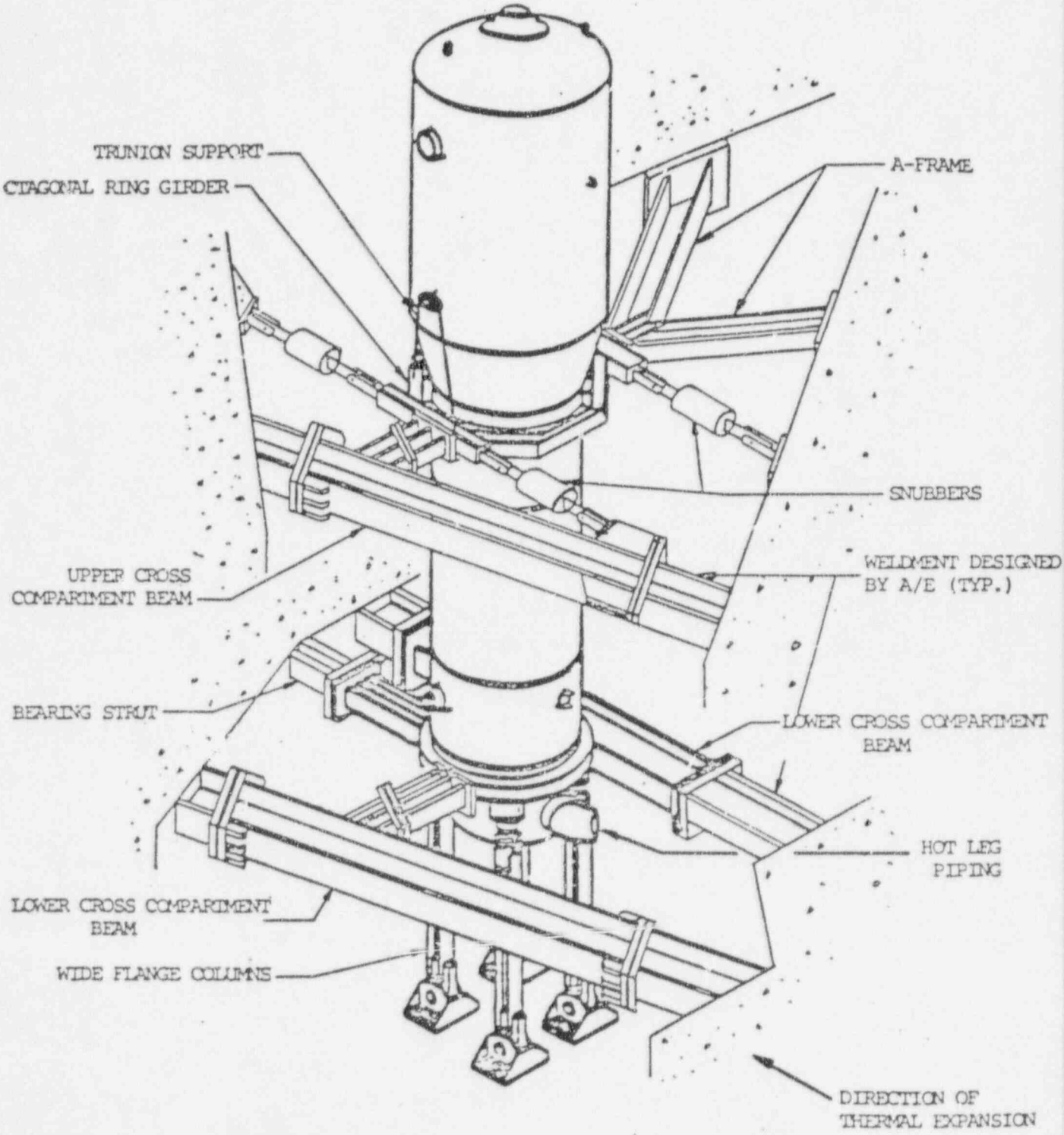
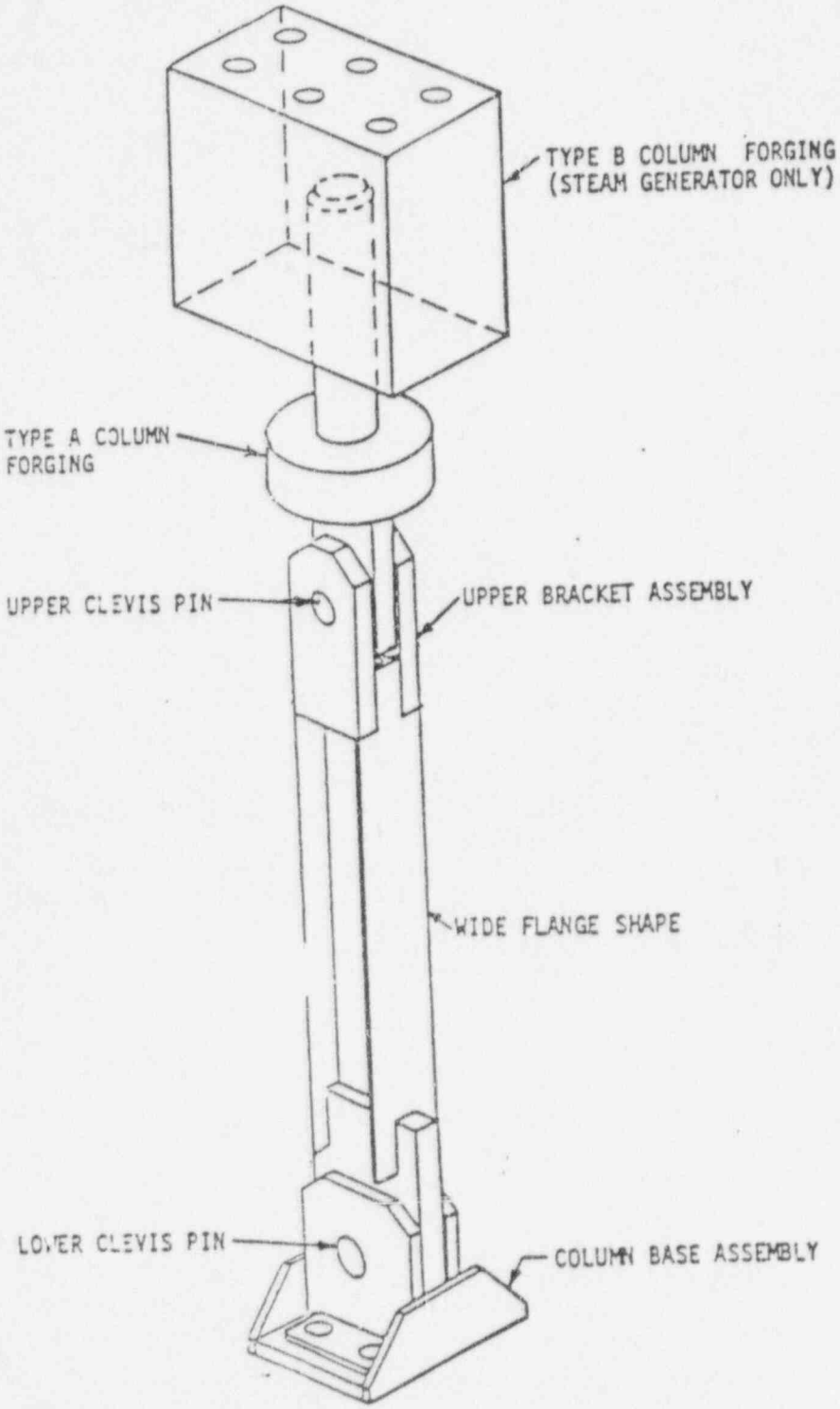


Tube Support Plate Archives

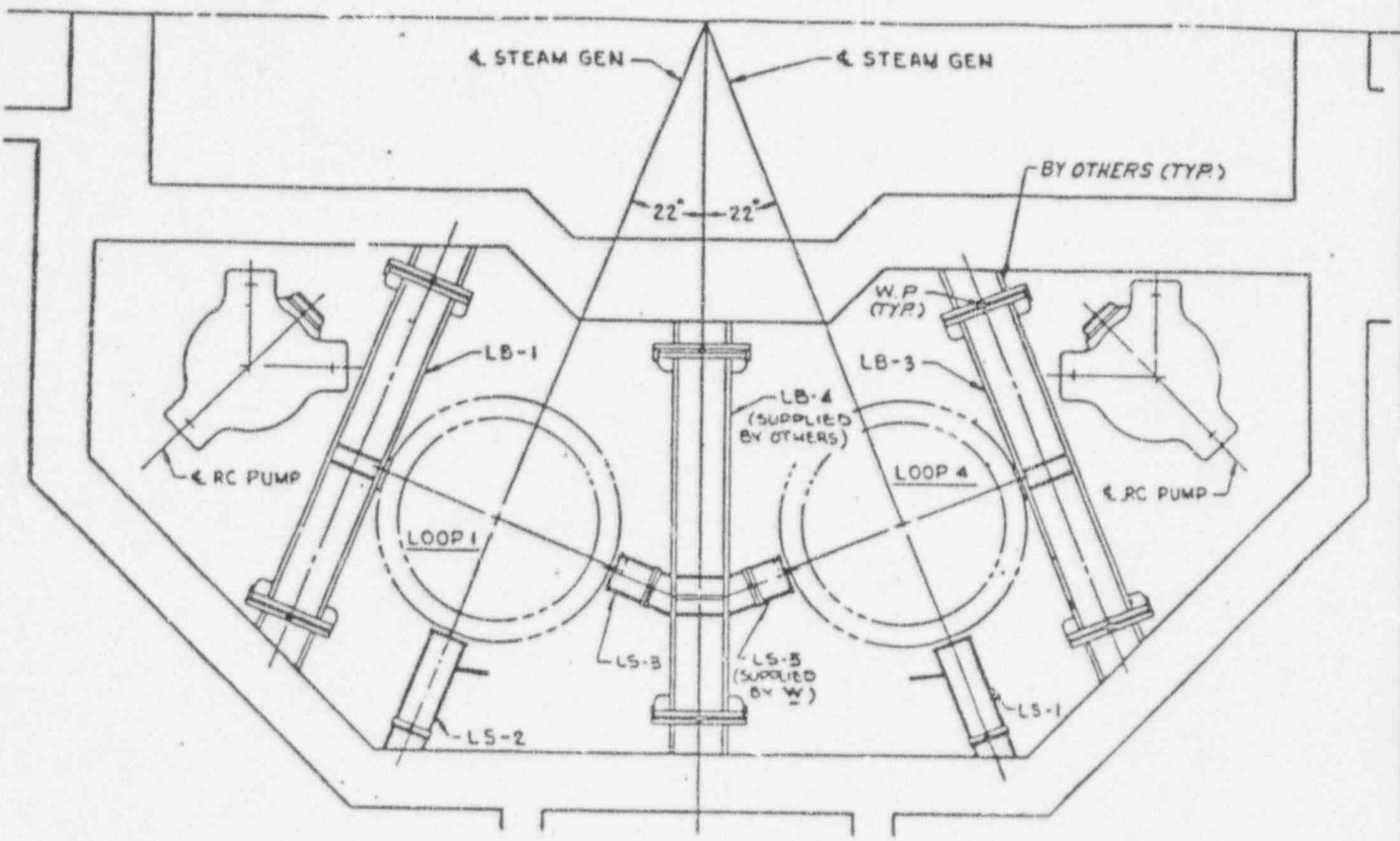
Additional Archives

AVB	1 Complete Anti-Vibration Bar
Tubing	1 U-Bend From Each Bend Radius With 2' Minimum Straight Leg Beyond Tangent Point.
	2 Straight Lengths Per Lot Prior To Thermal Treatment, 6' Minimum Each. Each From A Different Tube.
	2 Straight Lengths Per Lot After Thermal Treatment, 6' Minimum Each. Each From A Different Tube.
	400 Feet of Straight Tubes in Random Lengths in the Final Heat Treat Condition.


TRUNION SUPPORT
OCTAGONAL RING GIRDER
A-FRAME
SNUBBERS
WELDMENT DESIGNED BY A/E (TYP.)
UPPER CROSS COMPARTMENT BEAM
BEARING STRUT
LOWER CROSS COMPARTMENT BEAM
HOT LEG PIPING
LOWER CROSS COMPARTMENT BEAM
WIDE FLANGE COLUMNS
DIRECTION OF THERMAL EXPANSION

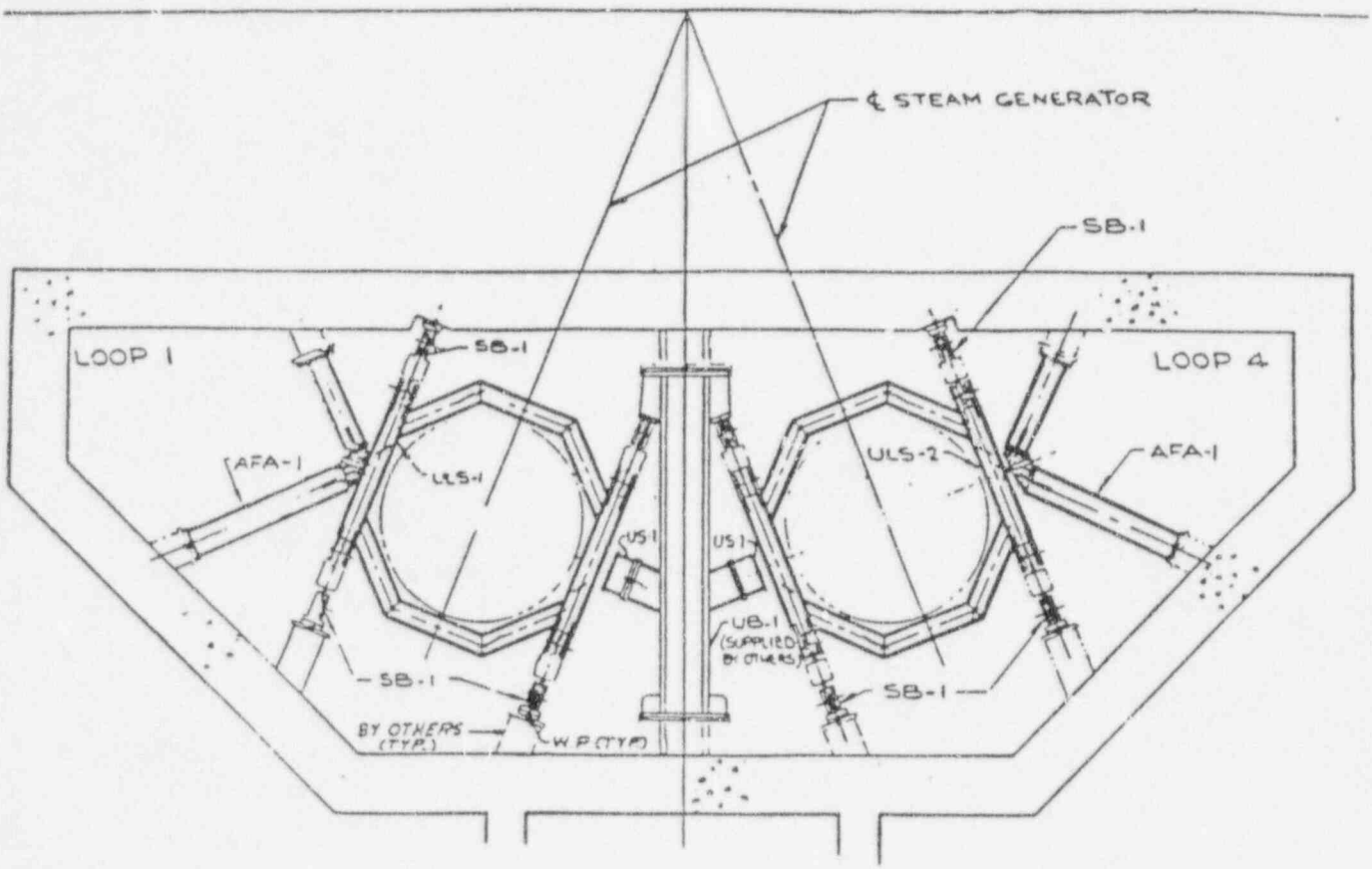


STEAM GENERATOR AND REACTOR
COOLANT PUMP COLUMNS



Note: Loops 2 and 3 (not shown) symmetric to loops 1 and 4.

STEAM GENERATOR LOWER SUPPORT



Note: Loops 2 and 3 (not shown) symmetric to loops 1 and 4.

STEAM GENERATOR UPPER SUPPORT

EA-95-044
From : Engineering Analysis
WIN : 474-4573
Date : May 8, 1995
Subject: Steam Generator Safety Classifications

To : J. M. Martinez

cc: Safety Class Team:
M. C. Misvel
T. C. Watson
R. L. Sylvester
B. B. Hood
W. B. Middlebrooks
G. Bieberbach
E. M. Fitzpatrick

T. C. Allen
NEE Engineers

References:
1. ESBU Policy/Procedure 4.2 Rev. 0 dated 4/01/95, "Equipment Safety Classification."
2. Regulatory Guide 1.29 Revision 3 dated September 1978, "Seismic Design Classification."

The Safety Class Team has completed its assessment of steam generator internals safety classifications. The results are summarized in the attached Tables.

These safety classifications are consistent with the latest ESBU Procedures (Reference 1).

Also included in the Tables are the Seismic Category (per Reference 2), minimum material requirements with respect to applicable Codes and Standards, and a brief explanation for the selection basis.

This information will be used as a basis for defining ongoing and future steam generator safety classifications, seismic category, and material requirements in design specifications and RECAR's (Revised Classification Assignment Records). The design specification classifications and categories shall be used as a basis for selecting appropriate QA requirements and 10CFR21 applicability in accordance with Ref. 1.

M. C. Misvel
Engineering Analysis

Approved: W. B. Middlebrooks, Manager
Engineering Analysis

Approved: G. Bieberbach, Manager
Design Engineering

Attachments

TUBE BUNDLE SUPPORT SAFETY CLASSIFICATION

NO.	Item	Safety Class per ESBU Policy 4.2 Rev.0	Seismic Category (1)	Material Requirements	Basis for Safety Class
1	Tube Support Plates	SC3	I	ASME Sec. II	(3)
2	Wrapper Barrels	CL4	I	ASME Sec. II	(4)
3	Wrapper Cone	CL4	I	ASME Sec. II	(4)
4	Jacking Blocks	CL4	I	ASME Sec. II	(4)
5	Wrapper Position Blocks	CL4	I	ASME Sec. II	(4)
6	Wrapper Restraining Keys	CL4	I	ASME Sec. II	(4)
7	Wrapper Anti-Rotation Keys	NNS	NO	ASTM	(5)
8	Wrapper Anti-Rotation Key Blocks	NNS	NO	ASTM	(5)
9	Central Stayrod Anchor	SC3	I	ASME Sec. II	(3)
10	Stayrods	SC3	I	ASME Sec. II	(3)
11	Barrel to Barrel Weld Ring	NNS	NO	ASTM	(5)
12	Cone to Barrel Weld Ring	NNS	NO	ASTM	(5)
13	Wrapper End Landing Ring	CL4	I	ASME Sec. II	(4)
14	Jacking Studs	CL4	I	ASME Sec. II	(4)
15	Backup Rings	NNS	NO	ASTM	(5)
16	Spacer Pipes	SC3	I	ASME Sec. II	(3)
17	Stayrod Washers	NNS	NO	ASTM	(5)
18	Stayrod Nuts	CL4	I	ASME Sec. II	(4)
19	Wedges	CL4	I	ASME Sec. II	(4)
20	Shims	CL4	I	ASME Sec. II	(4)
21	Backup Bars	CL4	I	ASME Sec. II	(4)
22	Anti-Rotation Wedges	NNS	NO	ASTM	(5)
23	Anti-Vibration Bars	SC3	I	(2)	(3)
24	AVB End Caps	CL4	NO	ASTM	(4)
25	AVB Retaining Rings	CL4	NO	ASTM	(4)
26	AVB Retaining Bars	CL4	NO	ASTM	(4)
27	Flow Distribution Baffle	SC3	I	ASME Sec. II	(3)

UPPER INTERNALS SAFETY CLASSIFICATION

NO.	Item	Safety Class per OPR 2.2 Policy 4.2 Rev.0	Seismic Category (1)	Material Requirements	Basis for Safety Class
1	Upper Support Ring	CL4	I	ASME Sec II	(4)
2	Secondary Separator Assembly	CL4 (11)	I	ASME Sec II	(4)
3	Primary Separator Assembly	CL4 (10)	I	ASME Sec II	(4)
4	Sludge Collector Assembly	NNS	NO	ASTM	(5)
5	Feedwater Ring Assembly	SCJ (6)	I	ASME Sec II	(8)
6	Feedwater Ring Support System	SCJ (7)	I	ASME Sec II	(9)
7	Auxiliary Feedwater Pipe	CL4	I	ASME Sec II	(4)
8	Ladder Assemblies	NNS	NO	ASTM	(5)
9	Lower Deck Plate Assembly	CL4	I	ASME Sec II	(4)

MISCELLANEOUS ITEMS SAFETY CLASSIFICATION

NO.	Item	Safety Class per OPR 2.2 Policy 4.2 Rev.0	Seismic Category (1)	Material Requirements	Basis for Safety Class
1	Blowdown Pipe Assembly	NNS	NO	ASTM	(5)
2	Tubelane Blocking Plates	NNS	NO	ASTM	(5)

Notes:

General a) The principal Construction Code is not required to be ASME III. Appropriate criteria and design requirements shall be established and utilized by the design organization. The criteria may be based on the criteria established in applicable codes or standards for similar equipment.

b) For equipment items identified as Class 4, selected requirements from 10CFR50, Appendix B shall be applied to ensure that items or services furnished and installed meet specified requirements. Regulation 10CFR21 does not apply to Class 4 items.

1) Seismic Category I items are required to meet "pertinent quality assurance requirements of Appendix B to 10 CFR Part 50" (Reference: Regulatory Guide 1.29).

2) Material shall meet ASME Sec. II requirements except for final fabrication operations which shall comply with ASTM Standards as a minimum.

3) Provides support to Safety Class 1 component (tubes) or is necessary to support the the deadweight of safety class equipment. Item is not within the scope of the ASME B&PV Code.

4) Must resist failure that could prevent safety class equipment from performing its nuclear safety function.

5) Does not perform any nuclear safety function.

6) This safety class only applies to assembly items necessary to perform the nuclear safety function. Miscellaneous parts which make up the assembly such as backing rings, shims, etc. may be NNS.

7) This safety class only applies to structural items in the support system necessary to insure nuclear safety functions of the supported equipment. Miscellaneous parts which make up the support system such as backing rings, shims, etc. may be NNS.

8) Provides backflow restriction in case of failure of the feedwater line. Backflow restriction insures nuclear safety functions provided by other SC-1, -2, or -3 equipment because backflow restriction may be required to (1) prevent primary side overpressurization, (2) prevent secondary side overpressurization of other isolated steam generators, (3) prevent bulk boiling in the core, or (4) maintain stresses within allowable limits for other steam generator safety class items.

9) Provides structural support to the SC3 feedwater ring assembly.

10) This class only applies to structural items necessary to resist failure that could prevent safety class equipment (e.g., tubes) from performing its nuclear safety function. Miscellaneous parts which make up the assembly such as backing bars, downcomer rings, etc. may be NNS.

11) This class only applies to structural items necessary to resist failure that could prevent safety class equipment (e.g. tubes) from performing its nuclear safety function. Miscellaneous parts which make up the assembly such as vanes, drain lines, jacking mechanisms, etc. may be NNS.

REVISED CLASSIFICATION ASSIGNMENT RECORD

Form 554290 (10-85)

RECAR No.: 161

Prepared By:	Date:	Equipment Design Group:
MICHAEL C. MISYEL	11/21/95	PENSACOLA NUCLEAR EQUIPMENT ENGR.
Project/Plant:		**Component:**
GENERIC (SHOP ORDERS DATED AFTER 6/30/94)		STEAM GENERATOR
System:	**SPIN No.:**	**Internal S.O. No.:**
REACTOR COOLANT	RCPCSG	120

ITEM NO.	PART NUMBER	ITEM DESCRIPTION	STRAT.	CLASS	JUST.
		SEE ATTACHED LIST			

Comments:

APPROVAL SIGNATURES REQUIRED

Cognizant Equipment Design Mgr.: G. Richenbach /RDT	Date: 11/4/95	Cognizant Functional System Design Mgr.:	Date: 11/30/95
Cognizant Procurement Part Mgr.: R W Pilmer	Date: 11/28/95	Cognizant Nuclear Safety Engr.:	Date: 12/3/96

Steam Generator Safety Classifications

Item No.	Part Number	Item Description	Strat.	Class	Justif. (Note 1)
1	Not Applicable	Primary Side Pressure Boundary (including tube bundle)	Semi	SC-1	A.4.1.1
2	Not Applicable	Primary Channel Head Divider Plate	Part	SC-2	A.4.1.2(d)
3	Not Applicable	Secondary Side Pressure Boundary	Semi	SC-2	See Note 2
4	Not Applicable	Tube Support Plates	Part	SC-3	See Note 3
5	Not Applicable	Wrapper Barrels	Part	C-4	A.4.1.4(m)
6	Not Applicable	Wrapper Cone	Part	C-4	A.4.1.4(m)
7	Not Applicable	Jacking Blocks	Part	C-4	A.4.1.4(m)
8	Not Applicable	Wrapper Position Blocks	Part	C-4	A.4.1.4(m)
9	Not Applicable	Wrapper Restraining Keys	Part	C-4	A.4.1.4(m)
10	Not Applicable	Wrapper Anti-Rotation Keys	Part	NNS	A.4.1.5
11	Not Applicable	Wrapper Anti-Rotation Key Blocks	Part	NNS	A.4.1.5
12	Not Applicable	Central Stayrod Anchor	Part	SC-3	See Note 3
13	Not Applicable	Stayrods	Part	SC-3	See Note 3
14	Not Applicable	Barrel to Barrel Weld Ring	Part	NNS	A.4.1.5
15	Not Applicable	Cone to Barrel Weld Ring	Part	NNS	A.4.1.5
16	Not Applicable	Wrapper End Landing Ring	Part	C-4	A.4.1.4(m)
17	Not Applicable	Jacking Studs	Part	C-4	A.4.1.4(m)
18	Not Applicable	Backup Rings	Part	NNS	A.4.1.5
19	Not Applicable	Spacer Pipes	Part	SC-3	See Note 3
20	Not Applicable	Stayrod Washers	Part	NNS	A.4.1.5
21	Not Applicable	Stayrod Nuts	Part	C-4	A.4.1.4(m)
22	Not Applicable	Wedges	Part	C-4	A.4.1.4(m)
23	Not Applicable	Shims	Part	C-4	A.4.1.4(m)
24	Not Applicable	Backup Bars	Part	C-4	A.4.1.4(m)
25	Not Applicable	Anti-Rotation Wedges	Part	NNS	A.4.1.5
26	Not Applicable	Anti-Vibration Bars	Part	SC-3	See Note 3
27	Not Applicable	AVB End Caps	Part	C-4	A.4.1.4(m)
28	Not Applicable	AVB Retaining Rings	Part	C-4	A.4.1.4(m)
29	Not Applicable	AVB Retaining Bars	Part	C-4	A.4.1.4(m)
30	Not Applicable	Flow Distribution Baffle	Part	SC-3	See Note 3
31	Not Applicable	Upper Support Ring	Part	C-4	A.4.1.4(m)

Steam Generator Safety Classifications (Continued)

Item No.	Part Number	Item Description	Strat.	Class	Justif. (Note 1)
32	Not Applicable	Secondary Separator Assembly	Semi	C-4 (Note 6)	A.4.1.4(m)
33	Not Applicable	Primary Separator Assembly	Semi	C-4 (Note 7)	A.4.1.4(m)
34	Not Applicable	Sludge Collector Assembly	Semi	C-4 (Note 10)	A.4.1.4(m)
35	Not Applicable	Feedwater Ring Assembly	Semi	SC-3 (Note 8)	See Notes 4 & 11
36	Not Applicable	Feedwater Ring Support System	Semi	SC-3 (Note 9)	See Note 5
37	Not Applicable	Auxiliary Feedwater Pipe	Part	C-4	A.4.1.4(m) & Note 12
38	Not Applicable	Ladder Assemblies	Semi	NNS	A.4.1.5
39	Not Applicable	Lower Deck Plate Assembly	Semi	C-4	A.4.1.4(m)
40	Not Applicable	Blowdown Pipe Assembly	Semi	NNS	A.4.1.5
41	Not Applicable	Tubelane Blocking Plates	Part	NNS	A.4.1.5
42	Not Applicable	Steam Nozzle Flow Limiting Venturi Insert	Part	SC-3	A.4.1.3(k)
43	Not Applicable	Lifting and Handling Lugs	Part	NNS	A.4.1.5

Notes:

1. Justification is provided by referencing the appropriate paragraph from ESBU Quality Policy & Procedures Manual, Revision 0, 4/1/95, Policy/Procedure 4.2, Revision 0, 4/1/95, "Equipment Safety Classification."

2. The Secondary Side Pressure Boundary is classified in accordance with ANSI/ANS-51.1-1983, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants," Paragraphs 4.5.1 & 4.10.1.

3. These items provide support to Safety Class 1 components (tubes) or are necessary to support the deadweight of safety class equipment. These items are not within the scope of the ASME B&PV Code.

4. The Feedwater Ring Assembly provides backflow restriction in case of failure of the feedwater line. Backflow restriction insures nuclear safety functions provided by other SC-1, -2, or -3 equipment because backflow restriction may be required to (1) prevent primary side overpressurization, (2) prevent secondary side overpressurization of other isolated steam generators, (3) prevent bulk boiling in the core, or (4) maintain stresses within allowable limits for other steam generator safety class items.

5. The Feedwater Ring Support System provides support to the Feedwater Ring Assembly. Thus, it is the same class as the Feedwater Ring Assembly (SC-3).

Steam Generator Safety Classifications (Continued)

6. Class 4 only applies to secondary separator assembly structural components necessary to resist failure that could prevent safety class equipment (e.g. tubes) from performing its nuclear safety function. Miscellaneous parts which make up the assembly such as vanes, drain lines, jacking mechanisms, etc. may be NNS.

7. Class 4 only applies to primary separator assembly structural components necessary to resist failure that could prevent safety class equipment (e.g. tubes) from performing its nuclear safety function. Miscellaneous parts which make up the assembly such as backing bars, downcomer rings, etc. may be NNS.

8. Safety Class 3 only applies to feedwater ring assembly items necessary to perform the nuclear safety function. Miscellaneous parts which make up the assembly such as backing rings, shims, etc. may be NNS.

9. Safety Class 3 only applies to Feedwater Ring Support System structural components. Miscellaneous parts which make up the assembly such as backing rings, shims, etc. may be NNS.

10. Class 4 only applies to the sludge collector assembly and the spools and top plate which are part of the assembly. All other parts which make up the assembly (e.g. washers, collars, end plates, pipes, etc.) may be NNS.

11. The Feedwater Ring is not classified Safety Class 2 because it is a nonpressure retaining component outside the scope of the ASME B&PV Code.

12. The auxiliary feedwater pipe is an internal nonpressure retaining component and is not directly connected to the external auxiliary feedwater piping. It is therefore not a safety class item. The auxiliary feedwater nozzle is the interface component between the internal and external auxiliary feedwater piping.

SOUTH TEXAS RSG INTERNAL THREADED MEMBERS

Description	Quantity	Thread Size	Material	Locking Method
Stayrod Central Anchor	1	1.00 8UNC	Alloy 690	Refer to Stayrod
Stayrod	9	1.00 8UNC	SA696 Gr C	0.12" Fillet Weld to Carbon Stl. Nut
Wrapper Jacking Stud	24	2.25 UN	SA 36	0.13 Groove Weld
Wrapper Jacking Stud	250	1.5 UN	SA 36	0.13 Groove Weld
Wrapper Closure Plug	4	0.875-9 UNC	SA 739 Gr B22	Alloy 690 Lock Nut - Crimped
Feedwater Ring Plug	1	4.00 8UN	Alloy 690 Flg.	3 - .12" x .5" Long Fillet Welds
Dryer Jacking Bolts	1 per Dryer Bank	0.625"-11	SA 36	.06 x .5" Long " Fillet Tack Weld
Dryer Jacking Studs	2 per Dryer Bank	0.625"-11	SA 36	.06 x .5" Long " Fillet Tack Weld
Sludge Collect Spray Manifold	4 per Spray Head	0.500-13UNC	SA 36	12" x .5" Long Fillet Welds
Lower Deck Jacking Bolts	8	3.00-8UN	SA 36	.50" Fillet Weld All Around
Mid Deck Plate Jacking Bolts	5	3.00-8UN	SA 36	.50" Fillet Weld All Around

UT Calibration Blocks

INSPECTION	BLOCK MATERIAL	APPROX. FINISHED SIZE (LWT), IN.
Channel Head/Tube Plate Weld	SA-508 Class 3	20.0 x 7.0 x 5.25 (clad)
Tube Plate/"A" Barrel Weld	SA-508 Class 3a	12.0 x 7.0 x 3.25
Upper Shell Barrel "J"/Elliptical Head Weld: and Feedwater Nozzle/Upper Shell Barrel "H" Weld	SA-508 Class 3a	14.0 x 7.0 x 4.0
Primary Nozzle Knuckle Radius	SA-508 Class 3a	12.0 x 7.0 x 13.5 (clad)
Primary Nozzle/Safe End Weld	SA-336 F316LN or SA-336 Class F316	14.0 x 7.0 x 4.75
Feedwater Nozzle Knuckle Radius	SA-508 Class 3a	12.0 x 12.0 x 4.0