US-APWR Sump Strainer Stress Report

Non-Proprietary Version

March 2011

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Revision History (Sheet 1 of 2)

Revision	Page (Section)	Description
0 (Dec-2008)	All	Original issued
1 (Mar-2011)	2	Table of Contents - Changed page numbers
	3	List of figures: - Changed the figure and table pages
	4	Section 1.0, second paragraph first bullet: - Changed number of disks per strainer from 27 to 21
	6	Section 1.0, Figure 2 - Changed figure 2 to incorporate drawing changes
	10	Section 4.1, first paragraph - Analysis method changed from independent Strainer/Cover Plate model to dependent Strainer/Cover Plate model
	11	Section 4.1 Detailed Stack Disk Finite Element Model - Changed Disk size and number of disks per strainer
	13	Section 4.1, Figure 3 - Updated graphics shown in figure
	16	Section 4.1, Reduced Detail Stack Disk Model - Changed original number of segments from 27 to 23
	17	Section 4.1, Figure 6 - Updated graphic shown in figure
	18	Section 4.2, first paragraph - Last sentence deleted Section 4.2, Strainer Plenum Model, first paragraph - Reduced detail stack disk model changed from 9 to 7. Full detail model used for remaining strainers. Section 4.2, Strainer Plenum Model, second paragraph - Added full detail strainer model to first sentence Section 4.2, Strainer Plenum Model, third paragraph - Third paragraph added - Changed diameter of flow holes in plenum
	20	Figure 8 – Strainer Plenum Structural Model - Full detail Stacked Disk Model incorporated at two strainer locations. - Changed location of two full detail Stacked Disk models

Revision History (Sheet 2 of 2)

Revision	Page (Section)	Description
1 (Mar-2011)	21	Section 5.1, Debris Loads - Changed calculated Debris Weight for Strainer and Plenum. Added Plenum Debris Weight value used for structural analysis
	22	Section 5.1, Seismic Inertial Loads - Changed damping value
	23	Section 5.1, Figure 9 - Changed Horizontal Response Spectra curve
	24	Section 5.1, Figure 10 - Changed Vertical Response Spectra curve - Changed Sloshing Loads from 500 lbf to 465 lbf
	26	Section 5.2, Table 3 - Changed Load Combinations 4 and 10
	27	Section 5.2, Load Combinations THmtl - Changed POST LOCA accident temperature
	30	Section 6.0, Table 5 - Changed Acceptance Criteria for Fillet Weld Stress and Bolting Shear Stress
	31	Section 6.0, Note 9 - Clarification of shear plane considerations
	33	Section 7.0, Table 6 - Changed Interaction Ratios and added components to table Section 7.0, Table 7 - Changed Interaction Ratios
	33	Section 9.0 - Changed References 1, 2, 3, 4, 5, 6, 11, 12, 13, 14 and 15

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PREFACE

The standard US-APWR design utilizes a passive disk layer type of strainer system, “Sure-Flow Strainer (SFS)”, supplied by Performance Contracting Inc. (PCI)”. The qualification od structural integrity of the SFS specially designed for the standard US-APWR was subcontracted to the vendor, and the stress report was provided hereto.

AUTOMATED
ENGINEERING
SERVICES

Summary Report

US-APWR Sure-Flow® Strainer Assembly
Structural Analysis Summary Report

Prepared for:

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Revision Summary						
Revision No.	Affected Pages	Description	By	Checked	Approved	Date
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2	3, 4, 11, 13, 16, 17, 18, 20-24, 26, 27, 30, 33, 35, 28	Updated calculation for Revised Full-Strainer Coupled Analysis, New Design Temperature, New Seismic Data, and New Hydrodynamic Loads	Miguel A. Rosa 3/23/2011	Greg Havlik 3/23/2011	Scott J Mehm	3-25-11

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1.0 Introduction

The purpose of this report is to summarize the evaluation of the structural components of the Emergency Core Cooling (ECC) and Containment Spray (CS) Systems sump strainer assembly to meet the design requirements as stated in the US-APWR Purchase Specification (Reference [1]), Technical Specification (Reference [2]), Seismic Design Criteria Document (Reference [3]), and Design Control Document (Reference [4]).

The strainer stack is a series of perforated plate disks "sandwiched" onto a central core tube with gap spacers, tension rods and seismic rods serving the purpose of keeping the required spacing between disks and maintaining the stability of the structure. The ECC/CS sump strainer assembly is composed of the following two sub-assemblies:

- A strainer stack assembly composed of 21 individual disks fabricated from perforated stainless steel sheet and bolted together in vertical stacks (Figure 1). The disks are separated by spacers to form a stacked disk configuration. Each strainer stack has an interior core tube which channels the flow of water down to the underlying plenum. There are 9 vertical strainer stacks per sump which are supported by the stainless steel plenum assembly. 2

- A stainless steel plenum for each sump spans over the top of the sump opening and provides structural support for the strainer stacks (Figure 2). The plenum also serves to direct the flow from each of the nine strainer stacks to the sump opening. The plenum is tightly fit to the containment floor to form a seal to prevent debris from entering the sump.

The remainder of this summary report overviews the design Codes and Standards (Section 2.0), Materials (Section 3.0), Analysis Methodology (Section 4.0), Loads and Load Combinations (Section 5.0), Acceptance Criteria (Section 6.0), Evaluation Results (Section 7.0), Conclusions (Section 8.0), and References (Section 9.0).

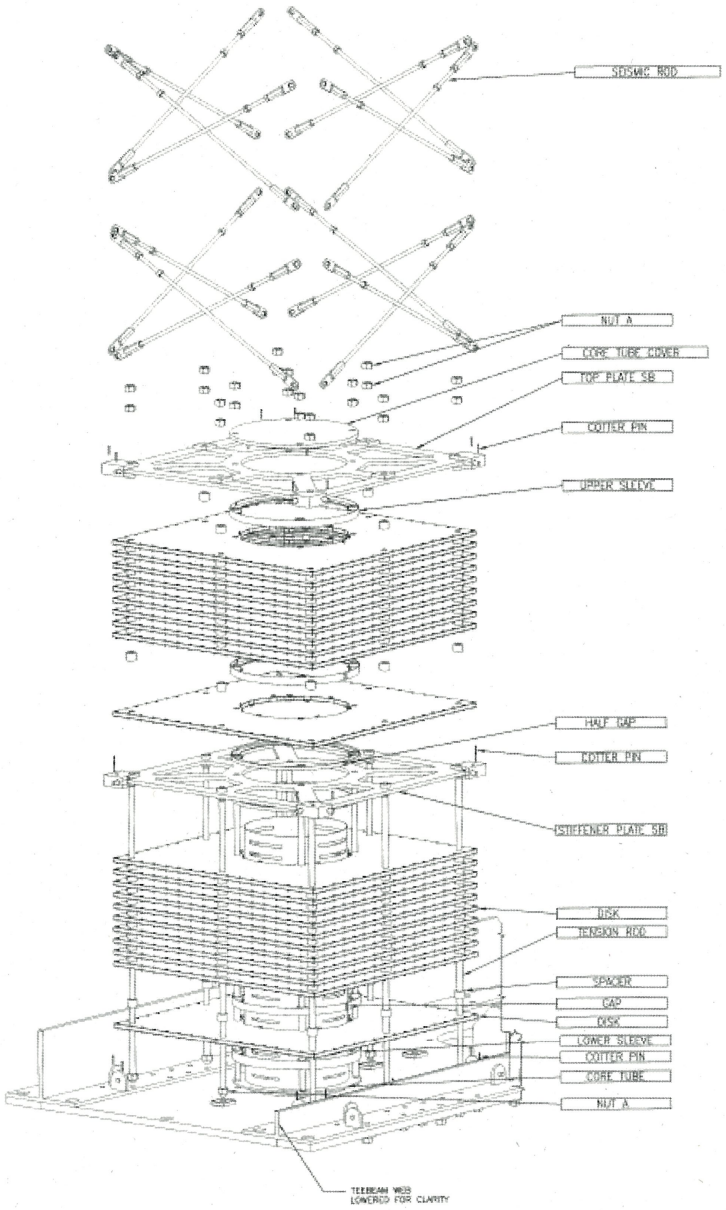

Figure 1 – Strainer Stack Assembly

Figure 2 – Strainer Plenum Assembly

2.0 Codes and Standards

The governing design Code for the US-APWR ECC/CS strainer assembly is specified in the US-APWR Technical Specification (Reference [2]), Seismic Design Criteria (Reference [3]), and the Design Control Document (Reference [4]).

In accordance with the Design Control Document (Reference [4]), the ECC/CS strainer assembly is classified as an ASME Boiler and Pressure Vessel Code, Section III, Division I, Class 2 component subject to the design rules of the 2001 Edition (up to and including the 2003 Addenda) of the ASME Code (Reference [5]). Accordingly, the pressure retaining components of the strainer stack and plenum (the perforated plates and plenum cover plates, respectively) are evaluated for compliance with the ASME Code, Subsection NC. The remaining components are considered component supports and are evaluated for compliance with the ASME Code, Subsection NF. Material properties are taken from the appropriate appendices of the ASME Code.

3.0 Materials

The strainer stack (Figure 1) is comprised of the following components fabricated from the materials indicated:

Table 1 - Strainer Stack Materials

Pressure Retaining Components	
Perforated Plate, Disks, Gap Rings	Stainless Steel, ASTM A-240, Type 304
End Cover Plate	Stainless Steel, ASTM A-240, Type 304
Grill Wire Stiffeners	Stainless Steel, ASTM A-493, Type 304 (Drafted to a min. yield strength of 70 ksi)
Rivets	Stainless Steel, Type 305 or ASTM A-240, Type 304
Component Supports	
Tension Rods	Stainless Steel, ASTM A-276, Type 304, Condition B
Nuts	Stainless Steel, ASTM A-194, Grade 8 (Heavy Hex)
Washers	Stainless Steel, ASTM A-240 or A-666, Type 300 Series
Stiffener Plates/Rings	Stainless Steel, ASTM A-240, Type 304
Spacers	Stainless Steel, ASTM A-312, Type 304
Seismic Rods	Stainless Steel, ASTM A-276, Type 304, Condition B
Seismic Rod Eyes	Stainless Steel, ASTM A-276, Type 304, Condition B
Seismic Rod Couplings	Stainless Steel, ASTM A-276, Type 304, Condition B
Connection Blocks	Stainless Steel, ASTM A-276, Type 304, Condition A
Connector Pins	Stainless Steel, ASTM A-276, Type 304, Condition B
Sleeves	Stainless Steel, ASTM A-240, Type 304
Long/Short Tabs	Stainless Steel, ASTM A-276, Type 304, Condition B
Weld wire/rod	Stainless Steel, ER308, ER308L, ER309, and ER309L electrodes

The strainer plenum (Figure 2) is comprised of the following critical components fabricated from the materials identified:

Table 2 - Strainer Plenum Materials

Pressure Retaining Components	
Cover Plates	Stainless Steel, ASTM A-240, Type 304
Component Supports	
Tee beam	Stainless Steel, ASTM A-240, Type 304
Nuts	Stainless Steel, ASTM A-194, Grade 8 (Heavy Hex)
Washers	Stainless Steel, ASTM A-240, or A-666, Type 300
Bolting	Stainless Steel, ASTM A-193, Grade B8, Class 2(Heavy Hex)
Weld Wire/Rod	Stainless Steel, ER308, ER308L, ER309, and ER309L electrodes