Westinghouse UK
AP1000® GENERIC DESIGN ASSESSMENT
Resolution Plan for GI-AP1000-SI-04
Containment Vessel

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Structural Integrity	-	5	0

GDA ISSUE:	Fracture Analysis of Containment Vessel.
ACTION: GI-AP1000-SI-04.A1	Provide sufficient evidence to show that the containment vessel has adequate tolerance to the thermal shock due to the flow of PCS water onto the top head. Activities required to be carried out by Westinghouse are: • Provide a report with the structure proposed during GDA to show that the containment vessel has adequate tolerance to the thermal shock due to the flow of PCS water onto the top head. • Provide adequate responses to any questions arising from assessment by ONR of documents submitted. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-SI-04.A2	Provide sufficient evidence to show that the containment vessel has adequate tolerance to small defects given the high residual stress associated with welds which have not undergone post weld heat treatment. It is anticipated that simple fracture mechanics calculations will be required to show adequate defect tolerance. It may be necessary to critically review the input parameters (design temperatures, pressures, residual stresses, likely manufacturing flaws etc) to ensure that they are self consistent and realistic. Activities required to be carried out by Westinghouse are: • Provide sufficient evidence to show that the containment vessel has adequate tolerance to small defects in the absence of post weld heat treatment. • Provide adequate responses to any questions arising from assessment by ONR of documents submitted. With agreement from the Regulator this action may be completed by alternative means.
RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE	
Technical Queries	TQ-**AP1000**-732 TQ-**AP1000**-1040 TQ-**AP1000**-1248
Regulatory Observations	
Other Documentation	

Scope of work:

The key activities which will need to be completed to close this GDA Issue are:

- Completion of the analysis to demonstrate that the containment vessel can withstand the thermal shock due to the flow of PCS water.
- Provide additional information to demonstrate that the containment vessel provides a sufficiently reliable barrier in the absence of post weld heat treatment of the welds.

Description of work:

Westinghouse is completing an analysis to demonstrate that the Containment Vessel (CV) will continue to perform its safety functions when subjected to the limiting stresses which occur when water from the passive containment cooling water storage tank (PCCWST) is poured on the CV during a design basis event with a mass and energy release inside containment. A bounding evaluation will be performed assuming cold water conservatively set to 4.4°C (40°F) is poured onto the CV top head. 4.4°C (40°F) is the minimum temperature of the water in the PCCWST per the Technical Specifications at which the plant can continue operations. The Passive Containment Cooling System (PCS) is equipped with heaters to maintain the water temperature above the minimum temperature during normal operations. When water from the PCCWST is initially poured onto the CV, pressure and temperature inside containment would typically be low; however, for the purpose of this assessment it is assumed that the CV will heat up to its design temperature and pressure of 148.9°C (300°F) and 406.8 kPa (59 psig) before the cold water is poured on the CV. This assumption is very conservative since during the limiting transient, which is a main steam line break inside containment, flow from the PCCWST is automatically initiated when pressure inside containment exceeds 42.75 kPa (6.2 psig). There are no load combinations with higher metal temperature or lower water temperatures as documented in the CV design specification. An appropriate metal temperature will be used to calculate the fracture toughness. The metal temperature used to calculate the fracture toughness values will be shown to be bounding. The methodology used to perform the assessment is described below. The appropriate residual weld stresses will be included in the calculation.

The assessment will demonstrate that the resulting stress intensity factors are below the calculated fracture toughness values and the evaluated critical flaw sizes are smaller than a realistic postulated defect.

The same assessment will also demonstrate that in the absence of post weld held treatment (PWHT), a small flaw will not result in failure of the CV, which was queried in TQ 1248. TQ 1248 queried what arguments and evidence show that the CV provides a sufficiently reliable barrier in the absence of PWHT. TQ 1248 was initially raised late in Step 4. The TQ was received by Westinghouse on January 11, 2011.

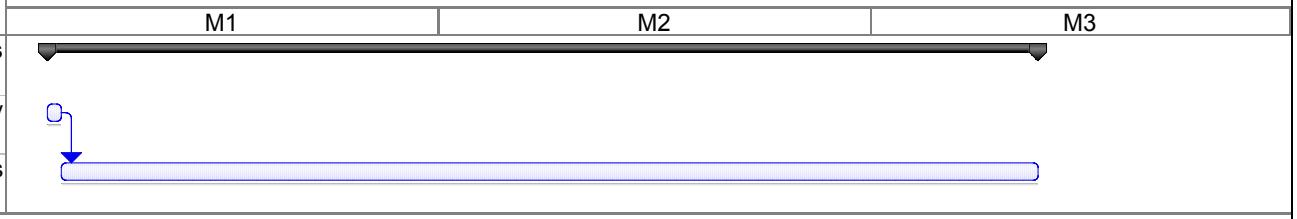
The **AP1000**® containment vessel is designed in accordance with the ASME Boiler and Pressure Vessel Code, Section III, “Rules for the Construction of Nuclear Power Plant Components,” Subsection NE. Section NE-4622.7 of the ASME code exempts vessels such as the **AP1000** CV from PWHT. Additionally, the fracture mechanics analysis described above will further demonstrate that the CV will not fail when subjected to limiting design transients with relatively large flaw sizes.

As part of the response, Westinghouse will justify that it has evaluated an appropriate and conservative load case as described above. The transient the TSC evaluated is an unrealistic transient. There is no **AP1000** transient where the containment vessel will not be coated in cooling water as design pressure increases. It is not possible that the outside of the vessel will be -28°C (18.4°F) when the pressurisation inside containment occurs. Containment design temperature is normally maintained at 21.1°C (70°F). It is not possible that the outer shell of the vessel could drop to its minimum design temperature assuming inside containment is initially approximately 21.1°C (70°F), there is a mass and energy release inside containment, and the vessel is coated in cooling water from the PCCWST that is no colder than 4.4°C (40°F). The evaluation described above will demonstrate that the CV provides a sufficiently reliable barrier in the absence of PWHT of the welds.

Schedule/ programme milestones:

Because all Resolution Plan start dates are subject to future contract placements, dates are presently unidentified; therefore schedule dates have been anonymised for consistency. Actual dates will be inserted when contracts are placed. The supporting fracture mechanics assessment for this resolution plan has already been completed. The attached schedule reflects that the assessment will be submitted once execution of Westinghouse resolution plans begins.

ID	Task Name	Duration
1	**SI.04 Resolution Plan**	**51 days**
2	Submit CV Fracture Mechanics Assessment	1 day
3	Support ONR Review	50 days



Project: Simple Resolution Plan
Date: Thu 16/06/11

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

Methodology:

The evaluated load case will be based on the transient described in the scope of work. The stress intensity factors will be calculated according to ASME 2010, Section XI, Division 1, Appendix A, Article A-3000, and the fracture toughness values will be calculated according to ASME 2010, Section XI, Division 1, Appendix A, Article A-4000. The fracture toughness values used are appropriate for the containment vessel and are consistent with the requirements of ASME Section XI, Article A-4200(b). The fracture toughness values taken from ASME XI will be shown to be conservative for the materials used for the containment vessel.

To account for the residual weld stress, the pressure stress, and the thermal stress due to the PCS actuation, a linear stress distribution through the thickness will be assumed. The thermal stress is calculated based on Hooke's law for a plate held at the edges with thermal expansion.

The calculations will demonstrate that the stress intensity factors are below the fracture toughness values and the evaluated critical flaw sizes are smaller than a realistic postulated defect.

Justification of adequacy:

Please refer to the description of work. The analysis described will demonstrate that the CV is tolerant to the thermal shock it will conservatively experience during a design basis accident. The analysis will also further validate that PWHT is not required to relieve residual weld stresses by demonstrating that a limiting transient will not challenge the structural integrity of the CV in the absence of PWHT.

Timely closure of the actions defined in this Issue will be reached through maintaining quality interaction with ONR and using existing processes to assure closure of open items.

Impact assessment:

The primary safety submission document potentially affected by this Issue is the PCSR. Based on closure of the issue, it may be necessary to update Appendix 20K of the PCSR.