US-APWR

Evaluation on Jet Impingement Issues Associated with Postulated Pipe Rupture

Non-Proprietary Version

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REVISION HISTORY

Revision	Page	Description
0	All	Original Issue
1	Abstract	Changed the contents
	1	Changed the section 1
	33 to 35	Changed all contents of section 3.3
	36 to 42	Added Section 3.4
	A3-1 to A3-21	Added Appendix 3
	A4-1 to A4-9	Added Appendix 4
	A5-1 to A5-12	Added Appendix 5
	A6-1 to A6-23	Added Appendix 6
2	Abstract	Change the contents
	24 to 26	Added Section 2.4 , 2.4.1 and 2.4.2 and Figure 2-24 about blast wave evaluation
	40	Revised Figure 3-10
	46	Revised the contents of section 3.4.4
	47	Added Table 3-3
	52	Revised the contents of section 4.1
	53	Revised Figure 4-8
	57	Deleted Equation 4-1 in Page 50 of previous revision due to typo
	54, 57	Changed the title of section 4.1.1 and 4.1.2
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ABSTRACT

Pipe rupture protection design is implemented to conform to Title 10 Code of Federal Regulations Part50, Appendix-A, General Design Criteria 4. The evaluation requirements and design policy described in this report are based on a defense-in-depth approach.
The calculation method for the thrust force and jet impingement force are described in a Technical Report “MUAP-10017”.

This report describes blast wave, jet pressure oscillation, and jet reflection calculation methodology.

The steam break blast wave is evaluated using CFD analysis with an instantaneous pipe break assumption. In the US-APWR, the term “steam piping” refers to the piping connected to the pressurizer upper head. Analysis, including consideration of plant layout, indicates that the blast wave does not impact the stress intensity of the SSCs and has no impact on the protection design. The change of layout in the future is considered, the evaluation methodology for blast wave is also provided.

Jet pressure oscillation is unlikely at the US-APWR operating pressures because the large jet flow expansion and large Mach Disk produce a stable downstream condition. Under such conditions, feedback from a disturbance at an impingement wall is unlikely. However, It is conservatively assumed that a jet pressure oscillation occurs through full blowdown process. The evaluation for jet pressure oscillation is provided.

When jet flow impinges on a wall, the impinging jet flow is redirected along the surface of the wall forming what is called the zone of influence (ZOI). Inside the ZOI, the impingement pressure includes effect of pressure due to flow parallel to the wall. Loads due to jet impingement reflection inside the ZOI are negligible. This report considers jet impingement on a parallel wall and the more likely case of an oblique.

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The following list defines the acronyms used in this document.

MHI	Mitsubishi Heavy Industries, Ltd.
NRC	U.S. Nuclear Regulatory Commission
CFR	Code of Federal Regulations
GDC	General Design Criteria
CFD	Computer Fluid Dynamic
RCL	Reactor Coolant Loop
PLIF	Planar Laser-induced Fluorescence
ZOI	Zone of Influence
RCL	Reactor Coolant Loop
RCPB	Reactor Coolant Pressure Boundary

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A3-1	RCS	Residual Heat Removal System (RHRS) Hot Leg Branch Line off RCS	10	B	Hot Leg		
A3-2	RCS	RHRS Hot Leg Branch Line off RCS	10	A, C, D	Hot Leg		
A3-3	RCS	RHRS Cold Leg Branch Line off RCS	8	B	Cold Leg		
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Figure No.	System	Subsystem	Nominal Diameter (Inches)	Loop	Break Location	Single Phase Steam Start Time(s)/ Pressure(lb/in^2)	Single Phase Steam End Time(s)/ Pressure(lb/in^2)
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A3-14	CVS	Seal Injection Line	1.5	B	RCP		

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(Hot Leg 10-inch Break - B Loop)

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