US-APWR

Evaluation on Jet Impingement Issues Associated with Postulated Pipe Rupture

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Revision History

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Abstract

Pipe rupture protection design is implemented to conform to 10 Code of Federal Regulations ("CFR") Part50, Appendix-A, General Design Criteria ("GDC") 4. Evaluation requirements and design policy are shown specifically in this standard based on the concept of deep-layered protection at nuclear plant.

The protection design standard for pipe rupture protection in US-APWR and specifies the calculation method for the thrust force and jet impingement force are described in a Technical Report "MUAP-10017".

This report is described about blast wave, jet pressure oscillation and jet reflection in the protection design standard for pipe rupture protection in US-APWR.

Blast Wave is generated in steam piping by the CFD analysis on the assumption of instant piping break and some report . In US-APWR, the steam piping is pressurizer upper part piping. As results for CFD, Structural analysis and plant layout , blast wave do not impact on structural intensity of SSCs. Therefore, In US-APWR, blast wave does not impact on the protection design.

Jet pressure oscillation is unlikely to occur in high compression ratio like US-APWR. Large jet flow expansion and large Mach Disk make downstream from Mach Disk stable. Disturbance at impingement wall does not reach back to Mach Disk. If pressure oscillation occurred, frequency would be high and resonance to surrounding SSCs is unlikely.

When jet flow impinges on perpendicular wall, impinged jet flow is redirected and runs along surface of wall. Zone of influence (ZOI) obtained by CFD is enveloped by estimated ZOI from MHI's design methodology. Inside of ZOI, impingement pressure includes effect of pressure due to flow parallel to impingement wall. Loads due to jet impingement reflection outside of ZOI are considered so small that it is not necessary to be considered. Additionally, design method of the oblique wall reflection is provided in this report.

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List of Acronyms

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

1.0 OVERVIER

2.0 BLAST WAVE

2.1 Blast Wave of Steam Piping

2.1.1 Free Blast Wave

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1.1 The Steam Ball

1.2 The Shocked Gas Region

1.3 Blast Confined to Uniform Area Progression

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