Appendix-C2

Severe Accident Analysis Report for Rapid Depressurization

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1.0 INTRODUCTION

The Rapid Depressurization (RD) function plays diverse roles during Design Basis Accidents (DBA), Beyond DBAs (BDBA), and severe accidents. The depressurization for a severe accident using RD function enables operation of the low pressure systems, such as Shutdown Cooling (SC) system. Additional contingencies for core cooling are made available by maintaining a low Reactor Coolant System (RCS) pressure when primary core heat removal functions are lost. Finally, maintaining a low RCS pressure prevents the High Pressure Melt Ejection (HPME), and prolongs the reactor vessel integrity.

In this report, the RD analysis was performed for APR1400. The RD function is performed for prevention of HPME, which would result in corium entrainment and direct containment heating. The depressurization capability was evaluated using MAAP (Modular Accident Analysis Program) 4.0.8 (Reference 1).

2.0 REQUIREMENTS AND CRITERIA

The RD function is implemented in compliance with SECY-93-087 (Reference 2), which prescribes the necessity of mitigation of the potential containment risks due to Direct Containment Heating (DCH) resulting from HPME via depressurization of the RCS before the reactor vessel fails.

To mitigate the DCH phenomena resulting from HPME, the RCS pressure should be kept below a certain level before vessel failure, and the reactor cavity should be able to reduce the entrained transport of the core melt to the containment dome region. The criterion of RCS pressure for the RD is prescribed as below 1.72 MPa (250 psia). This criterion of 1.72 MPa (250 psia) was obtained from a number of relevant experiments and has been considered as a cutoff pressure below which the entrainment of the melt can be prevented. Additional information can be found in the Reference 3 and Reference 4.

It is assumed that the operator begins RD after recognizing that the plant enters the severe accident stage. For this report, three conditions are defined as severe accident entry conditions. The first condition is the generally recognized, Core Exit Temperature (CET) exceeding 922K (1,200°F). The second condition is once a Pilot Operated Safety and Relief Valve (POSRV) has been first automatically opened, provided that there is also a loss of ac power, after the steam generator is empty. This condition is imposed since the POSRV must be opened before loss of dc power. Similarly, the last condition to begin RD is one hour before battery depletion.

In addition to the criterion of RCS pressure at the time of vessel failure, there is another criterion that the POSRV temperature should not exceed 644K (700°F), or the design temperature of POSRVs when opened manually. The operability of the POSRV can be assured only when the temperature is lower than the design temperature.

Thus, the following three conditions are the basis of this report:

- The RD function operation is performed at the onset of severe accident, which for the purpose of this report is defined as either:
  - After CET exceeds 922 K (1,200 °F), or,

  - Once a POSRV has been first automatically opened, provided that there is also a loss of ac power, after the steam generator is empty, or,
  - One hour before battery depletion for a station blackout.
- POSRVs can be opened only when the pressurizer gas temperature is lower than 644 K (700 °F)
- RCS should be depressurized below 1.72 MPa (250 psia) before the vessel fails.

The depressurization evaluation is considered successful if the last condition is met for each of the sequences considered.

3.0 ANALYSIS METHODOLOGY

In order to determine the containment performance of the APR1400 design under severe accident conditions, the MAAP 4.0.8 code is used to analyze a range of possible sequences. The method of selecting the sequences to be analyzed is discussed in Section 3.1. And the MAAP model of APR1400 is discussed in Section 3.2.

3.1 Selection of Accident Scenarios

Accident scenarios were selected by probabilistic means. The ten most likely core damage scenarios were selected based on the PRA results as shown in Table 3-1.

The following sequences will result in a low-pressure vessel failure, based on the sequence definition alone. Therefore, no further analysis will be performed for the following sequences:

- R2_MLOCA003
- R6_SLOCA008
- R7_PR-A-SL007
- R8_MLOCA002

Table 3-1 Dominant PRA Sequences

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3.2 MAAP Model of APR1400

The MAAP model for APR1400 is specified in the parameter file. The sequence definitions are specified in individual input files. The MAAP model for the APR1400 containment consists of 36 nodes and 88 junctions. The APR1400 nodalization diagrams can be found in Table 3-2 and Figures 3-1 through 3-8.

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Table 3-2 APR1400 Containment Node Description

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Figure 3-1 Containment Nodalization Diagram for APR1400

Security Related Information- Withheld Under 10CFR2.390

Figure 3-2 Containment Nodes in Section A-A

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Figure 3-3 Containment Nodes in Section B–B