19.36 Reactor Coolant System Depressurization

19.36.1 Introduction

Depressurization of the reactor coolant system is required for the external water cooling of the reactor vessel that will prevent vessel failure and core debris relocation to the containment (Reference 19.36-1). If the reactor coolant system (RCS) is at high pressure during core damage, containment failure may be postulated by several severe accident phenomena including induced failure of the steam generator tubes, high-pressure melt ejection, and direct containment heating.

19.36.2 Definition of High Pressure

High pressure is defined to support the assumptions of the PRA model. Induced steam generator tube rupture, high-pressure melt ejection, and reactor vessel failure into the flooded cavity will not occur if there is successful reactor coolant system depressurization.

Vessel failure can occur at elevated pressures with melted core debris in the vessel. This could cause the ejection of core debris from the vessel, followed by entrainment of debris in the high-velocity steam and water blowdown that would follow. Direct containment heating (DCH) and shifting of the reactor vessel are postulated containment failure mechanisms related to high pressure ejection of molten core debris.

Vessel failure and ex-vessel severe accident phenomena are prevented in the AP600 by external cooling of the reactor vessel when the cavity is flooded. Flooding of the cavity occurs when the in-containment refueling water storage tank (IRWST) water fills the cavity. This can happen because of depressurization and subsequent in-containment refueling water storage tank water injection or when the cavity flood lines on the in-containment refueling water storage tank are opened. This cooling confirms the core debris will remain in the vessel. Heat transfer from the molten debris in the vessel through the lower head will thin the vessel wall and reduce the capability of the vessel to withstand higher pressures. Based on Reference 19.36-3, the maximum static pressure that the damaged reactor vessel can withstand is approximately 400 psig. It is conservatively assumed in this analysis that molten core debris in the vessel could cause failure at pressures greater than 150 psig.

If there is no molten core debris in the vessel, the vessel and the rest of the reactor coolant system, including the stream generator tubes, are expected to remain intact at pressures up to 3200 psig. This is consistent with the design of the reactor coolant system primary side.

19.36.3 References

19.36-1 Theofanous, T. G., et. al., "In-Vessel Coolability And Retention of a Core Melt," DOE/ID-10460, July 1995.

19.36-2 Deleted.

19.36-3 Theofanous, T. G., et. al., "Lower Head Integrity Under In-Vessel Steam Explosion Loads," DOE/ID-10541, issued for peer review, July 1996.

19.37 Containment Isolation

Containment isolation is required before significant fission-product release after core uncovery. If the containment is not isolated, then the core damage results in a fission-product release to the environment. Containment isolation following an accident is achieved automatically by the protection and safety monitoring system or by the operator as instructed by an Emergency Response Guideline.

19.38 Reactor Vessel Reflooding

Reflooding of the in-vessel core debris will occur following an accident if the reactor coolant system is sufficiently depressurized and if the in-containment refueling water storage tank water can enter the reactor vessel, either through one or both in-containment refueling water storage tank gravity injection lines or through a break in the reactor coolant system.

Successful reflooding of the reactor vessel following an accident that resulted in core damage provides additional cooling to core debris and the vessel wall. It may also have the undesirable effect of leading to the production of hydrogen if water reacts with unoxidized zirconium and molten core debris.