APR1400 RESPONSES TO ACTION ITEMS FROM PRA PUBLIC MEETING
(April 13~15, 2015)

Probabilistic Risk Assessment and Severe Accident Evaluation

19-115(SA-2) : 10 CFR 52.47(a)(23) requires for light-water reactor designs to provide a description and analysis of design features for the prevention and mitigation of severe accidents, e.g., challenges to containment integrity caused by phenomena including hydrogen combustion. Section 19.2.3.3.2 Hydrogen Generation and Control of APR1400 DCD Rev. 0 describes hydrogen igniters but the sources of power to the igniters is not mentioned. The staff could not find the sources of power to the igniters in the DCD and the redundancy of power available to the igniters.

Response: The source of power to the igniters is from an electrically isolated division II class 1E power bus. In the event of a loss of division II class 1E power bus, the hydrogen igniters are powered from an electrically isolated division I class 1E power bus. In the event of a loss of offsite power, the hydrogen igniters are powered from the emergency diesel generator. On loss of offsite power and failure of the emergency diesel generator to start of run (station blackout), the igniters are powered from the AAC generator. During the complete loss of AC power including AAC generator, the hydrogen igniters are powered from the non-class 1E dedicated DC battery. The source of power to the igniters is mentioned in Figure 6.2.5-1

Impact on DCD
DCD Sections 19.2.3.3.2.1 and 6.2.5.2.1 will be revised as shown in the attached DCD Tier 2 markup PRA AI 19-115.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical and Environmental Reports.

requirements are met. These locations are determined based on equipment and piping proximity as well as inspection and maintenance access. The PAR components and igniter assembly are designed to meet seismic Category I requirements.

with electric power as described in Subsection 6.2.5.2.1,

The PARs are self-actuated and require no electric power. Therefore, no operator action is required. The igniters, which supplement PARs, are intended to control hydrogen concentration within containment once the operator confirms that an extended core uncovery is in progress. The operators use specific accident management guidance that relies on RCS and containment instrumentation, such as in-vessel level monitoring instrumentation, core-exit thermocouples, containment and RCS pressure indications, and a direct measurement of containment hydrogen concentration.

Once activated, an igniter produces either periodic small local burns or a standing diffusion flame, either of which reduces the containment hydrogen concentration below the upward flammability limit. Thus, the HG system prevents hydrogen from accumulating to the point where a destructive hydrogen detonation might occur within the containment.

19.2.3.3.2.2 Analysis Methodology

Hydrogen control analyses were performed using the Modular Accident Analysis Program (MAAP), version 4.0.8 (Reference 13), to determine hydrogen mixing, distribution, and combustion inside containment. The containment model used for hydrogen control analysis consists of 36 control volumes, 83 flow paths, and heat structures. Figure 19.2.3-2 shows the nodalization scheme of the containment model. Table 19.2.3-2 provides a description of the individual nodes. The analysis also investigated the potential for hydrogen accumulation in the containment and the response of the hydrogen mitigation system.

The accident sequences to be analyzed were selected to cover the most probable core damage sequences from outcomes of Level 1 PRA plus representative LOCA sequences. As a result, five accident sequences — large-break, medium-break, and small-break LOCA (LBLOCA, MBLOCA, and SBLOCA), SBO, and total loss of feedwater (TLOFW) — were selected as representatives.

6.2.5.2 System Design

6.2.5.2.1 Provision against Severe Accidents

The PARs and HIs are designed to control or allow adiabatic controlled burning of hydrogen at fairly low concentrations to preclude hydrogen concentration buildup to detonable levels. The system is designed to prevent the global and local hydrogen concentration in the containment and the IRWST from exceeding 10 percent by volume during a degraded core accident with 100 percent fuel clad metal-water reaction in accordance with 10 CFR 50.44(c).

For the PARs, provisions are not required because they can be operated automatically and their function can be confirmed by technical performance specification. PARs do not need to be grouped because they work independently.

Although HI is classified as Non-class 1E, the electrical power for HIs is supplied from the Class 1E bus (Train A or B) with the electrical isolation device in order to enhance the reliability of HIs. At loss of offsite power and failure of the emergency diesel generators to start or run (station blackout), the HIs have the alternative power supply from the alternate alternating current (AAC) generator. During a complete loss of AC power including from the AAC generator, the HIs are powered ~~from the DC battery.~~ from Non-class 1E, dedicated DC battery.

The hydrogen burning by HI or the hydrogen recombination heat is not critical for the survivability of critical plant equipment.

Although the containment is designed to distribute the hydrogen concentration uniformly, the hydrogen mixing is promoted and augmented by PAR operations, and if necessary, the PARs and HIs are positioned in areas where hydrogen release and accumulation are expected during severe accidents.

The PARs and HIs components in the containment and IRWST are designed to withstand severe accident environmental conditions.

The PARs and HIs are designed to prevent any significant pocketing of hydrogen to minimize the potential of localized hydrogen detonation.

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19-118(SA-5) : Section 19.2.2.5 of APR1400 DCD Rev. 0 states that “This SCS line design satisfies the ISLOCA acceptance criteria because all sections of the system and interfaces are designed to withstand full RCS operating pressure, or they have leak-test capabilities, valve position indications in the control room that function even when isolation valve operators are de-energized, and high-pressure alarms to warn operators when pressure is approaching the design pressure. Deletion of the interfaces from the SCS lines eliminates the potential for an ISLOCA without adversely affecting the performance or operations of the SCS.” It is unclear why the first sentence implies the presence of interfaces between SCS and RCS while the second sentence states deletion of such interfaces.

Response: The description in Section 19.2.2.5 of APR1400 DCD Rev. 0 will be revised to clarify the design features. As such, the SCS system design satisfies the ISLOCA acceptance criteria because all sections of the system and interfaces are designed to withstand full RCS operating pressure and eliminates the potential for an ISLOCA without adversely affecting the performance or operations of the SCS.

Impact on DCD
The DCD will be revised as shown in DCD Tier 2 markup PRA AI 19-118.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specification
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Report
There is no impact on any Technical, Topical and Environmental Reports.

are designed to withstand full RCS operating pressure or have a leak-test capability. In addition, the valve position indications in the control room function even when the isolation valve operators are de-energized, and high-pressure alarms sound to warn operators when pressure is approaching the design pressure. These design features protect the SIS lines and all interfacing systems from an ISLOCA challenge without adversely affecting performance or operations.

The shutdown cooling suction lines are connected to the RCS directly and are primary interfaces through which an ISLOCA event can begin. Pressurization is postulated from the hot leg and out of containment through the containment isolation valves to the low-pressure sections of the system. The shutdown cooling return lines are directly connected to the RCS directly and are primary interfaces through which an ISLOCA event can begin. Pressurization is postulated from the DVI nozzles and out of containment through the containment isolation valves to the low-pressure sections of the SCS.

This SCS line design satisfies the ISLOCA acceptance criteria because all sections of the system and interfaces are designed to withstand full RCS operating pressure, or they have leak-test capabilities, valve position indications in the control room that function even when isolation valve operators are de-energized, and high-pressure alarms to warn operators when pressure is approaching the design pressure. Deletion of the interfaces from the SCS lines eliminates the potential for an ISLOCA without adversely affecting the performance or operations of the SCS. These design features satisfy the ISLOCA acceptance criteria for the SCS line.

The SCS design satisfies the ISLOCA acceptance criteria because all sections of the system and interfaces are designed to withstand full RCS operating pressure.

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indirect interface through the SCS because the CS pumps, CS heat exchangers, SC pumps, and SC heat exchangers are interchangeable respectively. All connected CS sections are designed to 64.3 kg/cm^2 (900 psig). The only low-pressure system interface with the CSS is the spent fuel pool cooling and cleanup system (SFPCCS) connection to the refueling pool. This connection provides the ability to fill the refueling pool directly rather than through the reactor vessel. A spool piece connection is available to provide a method of physical separation of the low-pressure SFPCCS from any pressurization source in the CSS.

The CVCS letdown line is directly connected to the RCS and is a primary interface through which an ISLOCA event can begin. Pressurization is postulated from the letdown nozzle,

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19-119(SA-6) : Table 19.2.3-1 Hydrogen Control System Design Status of APR1400 DCD Rev. 0 identifies locations of only 2 of 8 igniters and 23 of 30 PARs. The staff could not identify locations of all the igniters and PARs on the table.

Response: The table inadvertently omitted igniters and PARs in the Steam Generator #1 and #2 Compartments and the Pressurizer Compartment. The DCD table will be revised to include the missed igniters and PARs.

Impact on DCD
DCD Table 19.2.3-1 will be revised as shown in the attached DCD Tier 2 markup PRA AI 19-119.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical and Environmental Reports.

Table 19.2.3-1

Hydrogen Control System Design Status

Security-Related Information – Withhold Under 10 CFR 2.390