SNC Answer Opposing BREDL Petition to
Intervene and Request for Hearing

Docket Nos. 52-025-LA-2; 52-026-LA-2

Exhibit No. 3

AP1000 SER (NUREG-1793), Initial Report, Section 6.2.5.1

Engineered Safety Features

The containment hydrogen control system serves the following functions:

- hydrogen concentration monitoring
- hydrogen control during and following degraded core or core melt scenarios (provided by hydrogen igniters)

In addition, two non-safety-related passive autocatalytic recombiners (PARs) are provided for defense-in-depth protection against the buildup of hydrogen following a LOCA.

The hydrogen ignition subsystem meets the requirements of 10 CFR 50.44 for future water-cooled reactors. The design must limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 100-percent, fuel clad-coolant reaction, uniformly distributed, to less than 10 percent (by volume), and maintain containment structural integrity and appropriate accident-mitigating features. This requirement was promulgated to address the lessons learned from the TMI accident. This type of accident is considered beyond the design basis and will be referred to as the severe accident case in this section. In the severe accident case, the hydrogen generation from the fuel clad-coolant reaction could be sufficiently rapid that it may not be possible to prevent the hydrogen concentration in the containment from exceeding the lower flammability limit. The hydrogen ignition subsystem is designed to promote hydrogen burning soon after the lower flammability limit is reached in the vicinity of an igniter. Initiation of hydrogen burning at the lower level of hydrogen flammability will prevent combustion at higher hydrogen concentrations, and provides confidence that containment structural integrity can be maintained during hydrogen burns.

6.2.5.1 <u>Hydrogen Ignition Subsystem</u>

For severe accident hydrogen control, the AP1000 containment has been provided with 64 hydrogen igniters. The igniter assembly is designed to maintain the surface temperature within a range of 870 °C to 927 °C (1600 °F to 1700 °F) in the anticipated containment environment following a LOCA. A spray shield is provided to protect the igniter from falling water drops (resulting from condensation of steam on the containment shell and on nearby equipment and structures).

The igniters have been divided into two power groups. Power to each group will be normally provided by offsite power. However, should offsite power be unavailable, then each of the power groups is powered by one of the onsite nonessential diesels. Finally, should the diesels fail to provide power, then the non-Class 1E batteries for each group will support approximately 4 hours of igniter operation. Assignment of igniters to each group is based on at least one igniter from each group providing coverage for each compartment or area.

The hydrogen ignition subsystem has been designed to promote hydrogen burning at a low concentration. Igniters have been placed in the major regions of the containment where hydrogen may be released, through which it may flow, or where it may accumulate. DCD Tier 2, Table 6.2.4-6, provides the criteria used in the evaluation and the application of the criteria to specific compartments. DCD Tier 2, Figures 6.2.4-5 through 6.2.4-13, provide the location of

igniters throughout containment. DCD Tier 2, Table 6.2.4-7, also summarizes the location of igniters, and identifies subcompartment/regions and which igniters by power group provide protection. The locations identified are considered approximations (± 1 m (2.5 ft)), with the final locations governed by the installation details.

The staff's review of the number and location of igniters focused on the major transport paths of hydrogen inside the containment to ensure that hydrogen can be burned close to the release point. One of the release paths considered was through the IRWST via the first three stages of the ADS. Two igniters are located within the IRWST below the tank roof of the IRWST and above the spargers. In the event of hydrogen releases from the spargers, the igniters directly above the release points will provide the most immediate point of recombination. In the event that the IRWST is hydrogen rich and air is drawn into the IRWST, the mixture will become flammable. To provide for this type of recombination, the two inlet vents, on the PRHR side of the IRWST, have each been fitted with an igniter. Should the environment within the IRWST be inerted or otherwise not be ignited by the assemblies above the sparger, the hydrogen can be ignited as it exhausts from the IRWST at any of four vents fitted with igniter assemblies.

Flow from the IRWST vents, located at Elevation 41.15 m (135 ft), exhausts into the upper compartment. Igniter coverage for the upper compartment includes 10 igniters at Elevations 49.4 m–53.64 m (162 ft–176 ft), 4 igniters at Elevation 69.5 m (228 ft), and 4 igniters at Elevation 78.33 m (257 ft).

Another important flowpath is through the fourth stage of the ADS which relieves, at Elevation 34.1 m (112 ft), into the SG compartments. Hydrogen flow into the SG compartment will be burned by two igniters at Elevation 36.58 m (120 ft) and 2 igniters at Elevation 42.37 m (139 ft). Hydrogen leaving the SG compartment is burned in the upper compartment. This flowpath would also apply to hydrogen released through any RCS break in the SG compartment.

Finally, the staff verified that the 15 major regions or compartments identified by Westinghouse in DCD Tier 2, Tables 6.2.4-6 and 6.2.4-7 had at least two igniters, and they included the enclosed areas within containment. Two enclosed areas, the reactor cavity and the north chemical and volume control system (CVS) equipment room, do not have igniter coverage or do not have igniters directly over the RCS piping. Hydrogen releases within the reactor cavity will flow either through the vertical access tunnel, through the opening around the RCS hot- and cold-legs into the loop compartments, or, if the refueling cavity seal ring fails, then potentially through the refueling cavity. Each of these adjacent regions or compartments has at least four igniters. The staff concludes that igniter coverage of the reactor cavity is not required because (1) the reactor cavity would most likely be flooded either through the break or by the cavity flooding system, (2) adequate igniter coverage is available in hydrogen pathways from the reactor cavity, and (3) any maintenance or inspection would result in elevated personnel exposure.

Although igniters have not been located directly over the RCS piping in the north CVS room, two igniters have been located near the ceiling of the equipment room between the equipment module and the major relief paths from the compartment. The staff finds this exception from the igniter location criteria in DCD Tier 2, Table 6.2.4-6 of DCD Tier 2 to be acceptable.

Engineered Safety Features

On the basis of the staff's review and Westinghouse's implementation of the igniter location criteria as listed in DCD Tier 2, Table 6.2.4-6 the staff concludes that adequate igniter coverage has been provided.

An additional consideration is the potential of generating significant concentration gradients within the containment during the course of the event. The staff does not expect significant stratification within the AP1000 containment based on the containment-mixing evaluation (below) and the number and location of igniters provided for the AP1000 containment.

The hydrogen ignition subsystem has been identified as one of the systems to be included in the equipment survivability program. DCD Tier 2, Appendix 19D and Appendix D to the AP1000 PRA discuss equipment survivability; Section 19.2.3.3.7 of this report evaluates this feature.

The hydrogen ignition subsystem conforms to the requirements of 10 CFR 50.44 by providing reasonable assurance that uniformly distributed hydrogen concentrations inside containment will not exceed 10 percent by volume.

6.2.5.2 Hydrogen Recombination Subsystem

The staff used the requirements of 10 CFR 50.44 to review the hydrogen recombination subsystem in the AP1000 design.

The hydrogen recombination subsystem, in the AP1000 design, serves no safety-related function, and therefore, has no nuclear safety design basis. The subsystem consists of two non-safety-related PARs installed inside the containment above the operating deck at approximate elevations of 49.4 m (162 ft) and 50.6 m (166 ft) respectively, each about 3.96 m (13 ft) inboard from the containment shell. The PARs recombine hydrogen and oxygen in the containment atmosphere to make water at a rate too slow to remove hydrogen from the containment atmosphere quickly enough to be of significant benefit during a severe accident. The PARs are provided for defense-in-depth protection against the buildup of hydrogen following a LOCA.

Based on its review, the staff finds that the hydrogen recombination subsystem is a non-safety-related system and serves no safety-related function, and its failure does not lead to the failure of any safety systems. The staff, therefore, concludes that the requirements of 10 CFR 50.44 are met, because hydrogen recombiners or similar systems are not required to control combustible gases during a design-basis LOCA. Based on the above, and the fact that its failure will not prevent safe shutdown, the staff finds the hydrogen recombination subsystem to be acceptable.

6.2.5.3 Containment Atmosphere Mixing

Another requirement of 10 CFR 50.44 for future water-cooled reactors is that all containments must have a capability for ensuring a mixed atmosphere during design-basis and significant beyond-design-basis accidents.