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January 30, 1996

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: T. R. QUAY

SUBJECT: WESTINGHOUSE RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION ON THE AP600

Dear Mr. Quay:

Enclosed are the Westinghouse responses to NRC requests for additional information on the AP600 Design Certification program. Enclosure 1 contains responses to five questions pertaining to hydrogen generation and control during a severe accident. A listing of the NRC requests for additional information responded to in this letter is contained in Attachment A.

These responses are also provided as electronic files in WordPerfect 5.1 format with Ms. Jackson's copy.

Please contact Cynthia L. Haag on (412) 374-4277 if you have any questions concerning this transmittal.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/nja

Enclosure

Attachment

cc: D. Jackson, NRC (1 copy enclosure)
J. Kudrick, NRC (w/o enclosure/attachment)
N. J. Liparulo, Westinghouse (w/o enclosure/attachment)

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Enclosure 1 to Westinghouse
Letter NTD-NRC-96-4633

January 30, 1996

Response to Follow-on Questions Pertaining to Severe Accident Hydrogen Generation and Control

480.116

10 CFR 50.63(a)(2), "Loss of all AC power," requires that the reactor core and associated coolant, control, and protection systems, including station batteries and any necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration. The PRA for the AP600 shows that station blackout sequences are a significant contributor to overall plant risk. The staff believes that hydrogen igniters are necessary to ensure containment integrity during a station blackout. Therefore, discuss the availability of the igniter system during various sequences including station blackout.

Response:

Station blackout sequences are not a significant contributor to the AP600 risk. The AP600 is designed to accommodate station blackout better than current generation plants. Station blackout contributes less than 0.2 percent to the core damage frequency.

The igniters are powered by each of the nonsafety-related diesel generators and by offsite ac power. In a station blackout sequence, the igniters are not available. The igniter availability, deflagration and detonation are factored into the quantification of the large release frequency and risk in the PRA. Less than 0.05 percent of the large release frequency is due to containment failure induced by hydrogen combustion. Therefore the availability of the igniter system during station blackout does not contribute significantly to the risk of the AP600.

480.117

In previously certified designs the staff has viewed power diversity and redundancy as important elements to demonstrate availability of the igniters. However, the AP600 igniter system is single train and, besides the normal on site and off site power supplies, the nonsafety diesel is the sole emergency power source. Discuss why the AP600 should have less quality, redundancy, and diversity than previously certified designs.

Response:

The AP600 has a large-dry containment with a nonsafety-related hydrogen control system in addition to a safety-related hydrogen control system. The igniters are not needed to meet the requirements of 10 CFR 50.34(f) as discussed in Chapter 46 of the AP600 PRA. The igniters are powered by three redundant power sources, the offsite power and the two nonsafety-related diesel generators. Diversity is provided by two sources: offsite power and the diesel generators. Station blackout is the only sequence in which all of these power sources fail concurrently. The AP600 is designed to accommodate station blackout better than current generation plants, so it has a negligible contribution (less than 0.2%) to the core damage frequency. Although on a single train, the igniters are located throughout containment such that each compartment has at least one primary and one secondary igniter (see also the response to RAI 480.40). The failure of the power sources and the igniters themselves is considered to be a more likely failure mode than the failure of the power distribution system.

480.118

Although the purpose of this meeting is to discuss severe accident hydrogen control the question of acceptable power supplies also applies to design basis events. The hydrogen control system includes recombiners for design basis events. The staff views equipment needed for design basis events as safety related. Discuss why the proposed non-safety power supplies are equivalent to previous designs.

Response:

The hydrogen control system design utilizing electric recombiners to provide design basis hydrogen control as discussed in Revision 0 of SSAR section 6.2.4 have been revised. The electric recombiners have been replaced with passive autocatalytic recombiners which utilize no electrical power supply. Therefore, concerns related to the qualification of recombiner power supplies is no longer valid. This design change was reflected in the draft submittal of SSAR section 6.2.4 via Westinghouse letter NTD-NRC-95-4504, dated July 10, 1995, and also summarized during the April 10 - 11, 1995 meeting with the NRC staff.

480.121

Mark III and ice condenser containments have specifically designed flowpaths. Mark III containments have been designed to force flow from the drywell to the wetwell through the suppression pool and ice condensers force flow to the bottom of the containment through the ice stacks to the containment dome. What are the flowpaths in the AP600? What is the database that supports these flowpaths? The staff is interested in drawings that would assist in understanding the overall layout of containment and where the igniters are located relative to the dominant accident flowpaths.

Response:

The AP600 containment layout drawings and igniters locations were provided to the staff along with discussions of the flowpaths from the designers and 3-dimensional drawings of the containment at a meeting with the NRC on April 10-11, 1995.

480.135

The staff is interested in discussing the differences between the criteria used by previously certified designs to locate hydrogen igniters and the criteria listed in Section 48 of the AP600 PRA. The following is a listing of some of the major differences:

- Placement of Igniters in closed and less well vented regions.
- Igniter locations are supported by an igniter pair in the same general vicinity.
- Compartments adjacent to the break compartment should have igniter coverage.
- Computer analyses such as MAAP and WGOTHIC are a valuable tool in assessing general trends. However, they are not sufficient in determining whether or not igniters are needed in a specific location.

- Detonation calculations have an important role in the overall assessment of the design.
- Equipment survivability should be addressed by determining the environment in the burning zones.

Response:

The design basis for the hydrogen igniter subsystem is discussed in Chapter 6 (Engineered Safety Features) of the AP600 SSAR, i.e. Section 6.2.4, Containment Hydrogen Control System. The function of the igniters is hydrogen control during and following a degraded core or core melt accident. The hydrogen igniter subsystem, since it is provided only to address a low-probability severe accident, is not a safety-related system, and is not designed to accommodate a single failure and is not a Class 1E subsystem. Station blackout, resulting in failure of the igniter power supply, contributes negligibly (less than 0.2%) to the core damage frequency of the AP600.

The hydrogen igniter subsystem consists of a single train of igniters that are powered by redundant power sources, including offsite power and either of the onsite stand-by diesel generators. The igniters are placed to provide backup for each igniter. The design basis is different than the design basis employed in previously certified igniter system designs as implemented in current light water reactor plants in the United States. However, each of the major differences identified have been addressed in the hydrogen control system design as discussed in the following paragraphs and references sections. The criteria as stated in Chapter 16 of the AP600 PRA used to locate the hydrogen igniters in the AP600 containment are consistent with the design basis provided in the AP600's SSAR.

The location criteria discussed and applied in Section 48 of the AP600 PRA incorporated engineering judgement which utilized insights on how hydrogen released during severe accidents in the AP600 plant is expected to behave in containment. The primary objective of installing the igniter system is to promote hydrogen burning at as low a concentration as possible and, to the extent possible, to burn hydrogen more or less continuously so that the hydrogen concentration would not build up in the AP600 containment. To achieve this goal, igniters were placed in all major regions of the containment where hydrogen may be released, through which it could flow, or where it may accumulate. The placement of the igniters is designers in such a manner that coverage for every region requiring hydrogen control is served by at least one primary and one secondary igniter. See response to RAI 480.40.

This approach for selecting hydrogen igniter locations resulted in the igniters being installed in each loop compartment. the tunnel connecting the loop compartments, the pressurizer compartment, the valve rooms, accumulator rooms, the IRWST vents, the CVCS room vicinity and above the operating deck. The containment igniters were located in the lower compartment, above the operating deck and near the top of the containment in the vicinity of the polar crane. This included placement of igniters within enclosed and less well vented regions. A total of 58 igniters were located in the AP600 containment. Failure of a single igniter to burn hydrogen was not modeled in the system fault tree due to the assumption that adjacent igniters compensate for such a postulated single igniter failure. The distribution of igniters presented for the AP600 containment includes those compartments adjacent to the potential break compartments which can serve as a source of hydrogen release into the containment. Two principal release locations are LOCAs in the loop compartments or the sparger in the IRWST. Chapter 48 of the AP600 PRA illustrates igniter coverage in adjacent compartments.

The AP600 design reliability precludes the potential for hydrogen concentration attaining detonable concentrations based on system design provisions and event probabilities. Detonation within AP600 containment and/or containment compartments is not a part of the project design basis.

Equipment survivability in the high temperature environments that could be produced during igniter initiated hydrogen burns is addressed in Section 10.2.6 (Elevated Temperatures) of the AP600 PRA and SSAR section 6.2.4.1.2.

Attachment A to NTD-NRC-96-4633
Enclosed Responses to NRC Requests for Additional Information

Re: Hydrogen Generation and Control

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