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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002748

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Subject: AP1000 Response to Request for Additional Information (SRP 8)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 8. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP8.3.2-EEB-09 R1

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

D. A. Lindgren /FOR

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Request for Additional Information on SRP Section 8

D063
NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 8

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP8.3.2-EEB-09
Revision: 1

Question:

The AP1000 is designed to sustain a load rejection from 100 percent power with the turbine generator continuing stable operation while supplying the plant house loads. The staff is concerned about the transient conditions where a significant voltage spike during islanding could cause high dc voltage conditions on the output side of the battery chargers. The operating experience (see Information Notice 2006-18) reveals that the voltage spike either due to malfunction of the main generator exciter or during islanding could go as high as 130% which could go undetected by normally provided relaying and could cause damage to the safety-related equipment or miss-operation. In this regard, describe how the protective features of the inverter and the new battery chargers would be coordinated so that any voltage transient will not result in inadvertent loss of the inverters or the batteries.

Westinghouse Response:

The load rejection from power effect on the IDS system was addressed in a previous RAI response. To summarize that response, the battery charger input circuit will conduct power to charge the batteries when AC power is available. This is recognized as the proper function of the battery charger in both the DCD and the FSER. The battery charger is specified to return to operation after voltage drifts outside of an acceptable input voltage range. The battery charger is also specifically defined within both the DCD and FSER as a qualified isolation device, isolating the battery and the inverter from the non safety related AC system. During the period where the battery charger is not conducting (if voltage goes out of range either high or low) the battery will carry the load. This is standard operation of a battery/ battery charger system in that the battery serves the load when the charger is not available.

The AP1000 has considered over-voltage events with the potential to have effects upon plant safety related equipment as provided under the direction of IN2006-18.

Specifically addressing the similarity of the Forsmark event referenced in IN2006-18, it is noted that there are several fundamental differences between a unit in Sweden and operating US plants, and additional differences between existing US plants and the AP1000.

- A first, fundamental difference is the potential to attribute magnitude of effect on the grounding system in country (Sweden) and in plant at the Forsmark unit. This is identified in footnote 1 of page 8 of the draft of the DIDELSYS task group report.
- Also, it is specifically noted in the NRC operating experience briefing (NPEC meeting 7/16/2008) that this event is "unlikely for US reactors".
- The OE briefing identifies US configuration of, "DC systems are supplied by battery chargers/ rectifier which are in turn powered from the AC distribution system". This is specifically the AP1000 configuration. (Slide 14) The configuration shown on slide 7 of the OE briefing shows the fault path between the rectifier and the inverter. This is not an AP1000 configuration. This configuration lent itself to propagating the fault.

- The OE briefing goes on to credit the EDG battery with the ability to "start and control the emergency diesel generator loads for about 2 hours". (Slide 14) This is the capacity of the AP1000 non safety related battery which starts and powers the controls of the non-safety related DGs.
- The AP1000 goes beyond this capability in that there is no requirement to start EDGs is order to achieve or maintain safe shutdown as the batteries alone have that capability without support of the DGs.
- It is recognized that "U.S. plants are required per the 10CFR50.63 to be able to keep the core cooled and maintain containment integrity with a loss off offsite power & unavailability of EDGs" (slide 15). The AP1000 accomplishes this station blackout scenario with safety related batteries alone.

In conclusion the AP000 has similar capability to existing US plants in capability to isolate and operate DGs to achieve required core cooling and containment integrity without EDGs through the use of non safety DGs, safety power systems, and the diverse actuation system powered from the non safety DC system and ultimately from an additional diverse internal UPS providing power for ultimate critical safe actions if required.

Question: OI-SRP8.3.2-EEB-09

In RAI-SRP8.3.2-EEB-09, the NRC staff stated that the AP1000 is designed to sustain a load rejection from 100 percent power with the turbine generator continuing stable operation while supplying the plant house loads. The staff is concerned about the transient conditions where a significant voltage spike during islanding could cause high dc voltage conditions on the output side of the battery chargers. Operating experience (see NRC Information Notice (IN) 2006-18, "Significant Loss of Safety-Related Electrical Power at Forsmark, Unit 1, in Sweden" dated August 17, 2006) has shown that the voltage spike either due to malfunction of the main generator exciter or during islanding could go as high as 130 percent which could go undetected by normally- provided relaying and could cause damage to the safety-related equipment or mis - operation. In this regard, the applicant was asked to describe how the protective features of the inverter and the new battery chargers would be coordinated so that any voltage transient would not result in inadvertent loss of the inverters or the batteries.

In a letter dated June 23, 2009, the applicant stated that the battery charger input circuit will conduct power to charge the batteries when ac power is available. The battery charger is specified to return to operation after voltage drifts outside of an acceptable input voltage range. The battery charger is also a qualified isolation device, isolating the battery and the inverter from the non-safety related ac system. During the period where the battery charger is not conducting the battery will carry the load. In addition, the applicant stated that it has considered over voltage events with the potential to have effects upon plant safety-related equipment as provided under the direction of IN 2006-18. However, the applicant did not provide the details of how to avoid this kind of event in AP1000 design or identification of potential vulnerabilities and actions that could reduce the challenges for the control room operators. This potential event is significant in that it can cause the common mode failure in all four trains and, therefore, could

result in the loss of all four trains of safety-related ac and dc power. Transient voltages on the ac input to the battery chargers can result in high dc voltages that could lead to failures of critical electrical and electronic components including electrical inverters unless they are properly protected. During such a voltage transient, the inverter voltage surge protection could trip before actuation of the battery charger protection if the battery charger and inverter direct current voltage protection settings are very close to each other. Therefore, it is necessary that the safety-related battery chargers and inverter trips be coordinated such that the associated inverters do not trip on during voltage transients on the ac distribution system. This is Open Item OI-SRP8.3.2-EEB-9.

Westinghouse Response to OI-SRP8.3.2-EEB-09:

For the AP1000, Westinghouse recognizes the need for voltage protection of battery chargers and inverters. WEC will require, as a part of the component design specification, a requirement that the UPS system (battery charger/ inverter) will be designed specifically with consideration of the Forsmark incident identified in IN2006-18. Industry evaluations of this incident identify the lack of coordination described in the RAI/ OI as a primary causative issue. Multiple class 1E manufacturers' equipment modeled the Forsmark incident and demonstrated that the equipment can selectively trip.

Protective devices will be set so that the battery charger will not trip on the over-voltage resulting from load rejection and will be set low enough to protect the equipment. Additionally, the inverter DC input protection will be set at least 10% higher than the rectifier (battery charger) output DC protection to prevent the inverter tripping before the rectifier (battery charger).

Reference(s):
None

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None