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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002537

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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-SRP8.3.1-EEB-04
RAI-SRP8.3.2-EEB-03
RAI-SRP8.3.2-EEB-08
RAI-SRP8.3.2-EEB-09

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
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/Enclosure

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

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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-SRP8.3.1-EEB-04
Revision: 0

Question:

DCD Section 8.3.1.4.2 states, "Each diesel generator is tested to verify the capability to provide 4000 kW while maintaining the output voltage and frequency within the design tolerances of 6900±10% Vac and 60±5% Hz. The 4000 kW capacity is sufficient to meet the loads listed in table 8.3.1-1 and 8.3.1-2." However, the sum of the total loads (automatic and manual) listed in each revised table exceeds the continuous rating of each diesel generator. Update the information in this section and justify why it is acceptable to exceed the continuous rating of the diesel generator at this stage of the design. Also, provide the provisions included in your design that will prevent overloading of the diesel generators when manual loads are powered from the diesel generator.

Westinghouse Response:

Please note that diesel generator sizing is part of the AP1000 certified design. The onsite standby diesel generators are nominal 4000 kW diesel generators, however the units will accept loads up to the vendor's prime and standby rating for the period of time specified for those ratings. Both of these values are above the 4000 kW rating providing margin for the defense in depth and as well as other intended diesel generator functions. The clear intent of the diesel generator loading philosophy is first to accept all automatic loads followed by loading of manual electrical loads dependent on the event and the capability of the diesel to accept additional loads but assuring defense in depth functions are satisfied.

As defined in DCD section 8.3.1.1.1, relative to the diesel generator loads listed in table 8.3.1-1 and 8.3.1-2.

> Those loads that are priority loads for defense-in-depth functions based on their specific functions (permanent nonsafety loads) are assigned to buses ES1 and ES2. These plant permanent nonsafety loads are divided into two functionally redundant load groups (degree of redundancy for each load is described in the sections for the respective systems). Each load group is connected to either bus ES1 or ES2. Each bus is backed by a non-Class 1E onsite standby diesel generator. In the event of a loss of voltage on these buses, the diesel generators are automatically started and connected to the respective buses.

Beyond defense depth functions, there are other basis as to why electrical loads have been included as manual loads for AP1000 and the capability to be loaded onto the onsite diesel generator has been incorporated into the design. These functions include investment protection, preventing onerous actuation of safety related system operation, preservation of the capability for cold shutdown, and maximizing event recovery capability. It is important to note that the demand for any of these functional basis are not necessarily concurrent and would not require all of the automatic and manual loads to be loaded simultaneously. For an example:

> The instrument air compressors do not provide a defense in depth function and therefore would not be required as load to support that function although the availability of instrument air assists the operator in a more routine recovery from a loss of offsite power event.
>
> The containment recirculation fans do not provide a defense in depth function but are capable of being loaded onto the diesel to provide for investment protection to those containment heat loads for which it is considered prudent to provide cooling air for limiting equipment and support damage following a loss of offsite power event.
>
> The CVS system has defense in depth functions to provide for makeup and boration to RCS. Although the CVS pumps accommodate that function, the pumps, depending on the scenario are not required to operate continuously and likely would be required infrequently and therefore, it would not be expected that they would be required to be loaded continuously and load management would permit termination of these pumps or similarly the startup feed pumps (also required infrequently).

In summary, the diesel generator sizing is part of the AP1000 certified design. The diesel generators are not required to be sized to support all loads that can potentially be loaded, but simply to support the necessary concurrent loads. The abnormal operating procedures as well as the certified system design for AP1000 support this design philosophy. The abnormal operating procedures include diesel generator load management details and subsequent to the automatic load sequencing, the procedure identifies that additional loads can be manually loaded at the operator's option. The operator will assess plant conditions and available diesel generator capacity to determine if these components should be started. The operator has main control room indication of the current power demand on each of the onsite standby diesel generator upon which to base his decisions.

Reference(s):
None

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP8.3.2-EEB-03
Revision: 0

Question:

Provide the load profiles (duty cycle) from one minute to 24/72 hours for each of the 24-hour and the 72-hour Class 1E 250Vdc batteries. Also, discuss battery margins (aging margin, design margin, temperature correction factor, margin associated with float current for 100% state of charge) and potential for thermal runaway and the expected service life of these batteries.

Westinghouse Response:

Duty cycle information will be made available during a design review. Nominal load information is available in DCD Revision 17, Tier 2, Chapter 8, Tables 8.3.2-1 through 8.3.2-4. Aging margin will be in line with the aging identified in the DCD and IAW IEEE485. For example, a factor of 25% would be used for a 20 year qualified battery. Temperature correction will be based on minimum tech spec temperature of 60 degrees Fahrenheit and IAW IEEE-485. For 60 degrees Fahrenheit this is a factor of 11%. This is conservative for batteries with long time discharge cycles. Working design margin is currently 10% IAW, the methodology of IEEE-485. Design margin is not required to demonstrate safe shutdown capability. Float current margin is described as a consideration for quick turnaround to service after discharge (IEEE 946-2004 section 5.2 paragraph b). This is not a required feature of the AP1000. The AP1000 utilizes a spare safety battery that can replace any safety related battery and thereby not place the additional challenge of a quick turnaround top service on the discharged battery. The topical reference also states that for nuclear applications this additional margin is not required if the postulated design basis scenario does not require multiple losses of offsite power.

VLA (flooded) batteries are not commonly identified with a thermal runaway effect. This phenomenon is commonly associated with VRLA batteries which are not used on the AP1000.

The replacement interval/ service life of the batteries will be in accordance with the testing program replacement requirements defined in the DCD. Replacement intervals will be based on degraded performance as defined in the required test program.

Reference(s):
None

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP8.3.2-EEB-08
Revision: 0

Question:

DCD Section 8.3.2.1.1.1 indicates that the operating voltage range of the Class 1E dc system has been changed from 125 vdc to 250 Vdc. Figure 2.6.1-1 of the Tier 1 DCD shows that the MCCs that feed the safety-related 250 Vdc battery chargers are fed from 480 V load center. Provide detailed drawing of the 480 V load centers, the MCC that feed the battery chargers and the dc motor control center showing typical loads powered from these buses. Also, describe how the 480 V load centers are protected from degraded voltage and frequency conditions. In addition, provide the following information:

a. Provide the results of an analysis of the onsite power distribution system to demonstrate that adequate voltages at terminal of the battery chargers are optimized for the maximum and minimum voltage variations of the offsite power for events, such as a unit trip, loss-of-coolant accident, startup or shutdown.

b. Provide a description of the analytical techniques, methodology, and assumptions used in performing the analyses. Also, provide the results of these analyses for each level of onsite electrical power distribution.

c. Identify the analytical software (and its version) used for performing these studies and make available to the NRC staff an electronic copy of the electrical distribution system model that form the basis of the analytical studies.

Westinghouse Response:

In DCD Revision 17, the operating voltage range of the Class 1E dc system was changed from 125 vdc to 250 Vdc, however, there was no change made in the interface between the non-safety AC system and the safety DC/UPS system. It is recognized in both the DCD and the FSER that the AC power system is not required to affect safe shutdown of the unit.

Finally, the level of design detail requested in items a, b, and c of this RAI is not yet available. As with other non safety related AP1000 systems, the level of detail requested in the RAI will be available to the NRC following the completion of the design review stage of the system.

Reference(s):
None

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP8.3.2-EEB-09
Revision: 0

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.

Reference(s):
None

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None