AP1000 Design Control Document

Amended Design

Chapter 8 – Electric Power

SER with Open Items – Status Update

AP1000 Licensing

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May 27, 2010

Westinghouse

Open Issue CI-SRP-8.3.1-EEB-02

Subject: Fast bus transfer initiates but fails to complete…

Westinghouse Position: Revised wording in DCD – WEC Action completed

NRC Feedback: Confirmed Resolution in SER with Open Items

Open Issue OI-SRP8.3.2-EEB-03

Subject: Provide load profiles for 24/72 hour batteries

Westinghouse Position: Provided to the NRC for review April 2010

NRC Feedback : Verbal Feedback - Resolved

Open Issue OI-SRP8.3.2-EEB-05

Subject: Provide battery sizing calcs, terminal voltage calcs, short circuit calcs, voltage drop for safety related batteries

Westinghouse Position: Provided to the NRC for review April 2010

NRC Feedback : Verbal feedback - Resolved

Open Issue OI-SRP8.3.2-EEB-08

Subject: Battery Chargers

- WEC to provide AC analysis to demonstrate adequate voltage at the battery chargers
- WEC to provide the results of calculations
- WEC to explain approach to transferring information to the COL applicant

Open Issue OI-SRP8.3.2-EEB-08 (cont.)

Westinghouse Response:

• Design information is transferred to an applicant using the "Electrical Transient Analysis Program" TM
• Explained the role of the battery charger
• Explained that Safe shutdown of the plant does not require the support of the battery chargers.
• ITAAC verifying that the battery chargers conform to the certified design descriptions is provided in DCD Tier 1, Table 2.6.3-3
• WEC will include in the component design specification, a requirement that a Factory Acceptance Test (FAT), a certified test report, and a Westinghouse Quality Assurance release be included in the battery charger/inverter design specifications

NRC Feedback : Add commitments to the DCD

Open Issue OI-SRP8.3.2-EEB-09

Subject: Transient conditions that could cause high dc voltage conditions on the output side of the battery chargers (IN 2006-18 Forsmark Unit 1)

- 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.

Open Issue OI-SRP8.3.2-EEB-09 (cont.)

Westinghouse Position:

- Not a design change or a safety case

- DCD Tier 1, Table 2.6.3-3 identifies ITAAC to verify the battery chargers and inverters conform to the certified design descriptions.

- WEC will include in the component design specifications, a requirement that the UPS system (battery charger/ inverter) will be designed specifically with consideration of the Forsmark incident identified in IN2006-18

Open Issue OI-SRP8.3.2-EEB-09 (cont.)

Westinghouse Position (cont.):

• The specification will also require a Factory Acceptance Test (FAT), a certified test report, and a Westinghouse Quality Assurance release.

•The components will be tested separately

•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.

• 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).

NRC Feedback : Add commitments to the DCD

Open Issue OI-SRP8.3.2-EEB-04

Subject: How will the batteries be qualified for service life - Provide a qualification test plan for NRC evaluation for 24/72 hour batteries

Westinghouse Position:

- Provided to the NRC for review March 2010
- WEC Test Plan is in compliance with Reg and Industry Standards
- The 125/250 Vdc design change does not change the battery discharge requirement
- The change does not change the safety function

Westinghouse

Open Issue OI-SRP8.3.2-EEB-04 (cont)

Subject: How will the batteries be qualified for service life - Provide a qualification test plan for NRC evaluation for 24/72 hour batteries

NRC Preliminary Feedback :

- Battery qualification has not been evaluated
- How will the batteries perform under extended duty cycle

AP1000 24Hr and 72Hr Battery Environmental and Seismic Qualification Program

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Westinghouse

AP1000 24Hr and 72Hr Batteries - Function

The Class 1E dc and UPS system provides reliable power for the safety related equipment required for the plant instrumentation, control, and monitoring and other vital functions needed for shutdown of the plant. In addition, the Class 1E dc and UPS system provides power to the normal and emergency lighting in the Main Control Room and at the Remote Shutdown Station.

AP1000 24Hr and 72Hr Batteries

Historical Background

- Present IEEE Std 535 does not provide for testing duty cycles
- Battery industry had evidence of significant aging mechanism based on previous testing
- Evidence determined 8hr discharge tests posed no significant cumulative effect
- Provided exception to discharge cycling due to evidence
- No evidence of longer duration duty cycles exist

AP1000 24Hr and 72Hr Battery

Historical Background

- Westinghouse has developed a program for environmental and seismic qualification of the AP1000 24 Hr and 72 Hr Class 1E 250 VDC Batteries in compliance with regulatory and industry requirements
- The program has been developed with the guidance of NRC Regulatory Guides 1.89, 1.100, and 1.158 and IEEE Std 323-1974, IEEE Std 344-1987 and IEEE Std 535-1986
- IEEE Std 535 provides criteria for demonstrating qualification of Class 1E vented lead acid batteries in compliance with IEEE Stds 323 and 344

AP1000 24Hr and 72Hr Batteries

General Concepts

- Changing from 125 VDC to 250 VDC is only a difference of a series vs parallel connection
- Changing from 125 VDC to 250 VDC does not affect qualification program. Three battery cells are required regardless of the total battery voltage; discharges measured volts per cell not total battery voltage
- IEEE Std 450 testing requirement is independent of total battery voltage and is based on volts per cell

AP1000 24Hr and 72Hr Batteries

Westinghouse Approach/Methodology

- Provide vendors with a qualification test plan equal to the maximum anticipated service requirements based on the rating of the battery
- Service conditioning simulated during testing are in accordance with AP1000 maintenance surveillance requirements with margin
- Margin of 10% added to the number of years resulting in longer thermal aging and two additional cycles (yr 21 and 22)
- Qualification program to be performed by battery vendors will address 24hr and 72hr duty cycles

AP1000 24Hr and 72Hr Batteries

- Number of tests in accordance with requirements of IEEE Std 450-1995
- Type 3 modified performance tests from IEEE Std 450-2002 serve as baseline and functional tests
- Trending possible due to consistency functional test
- Annual testing conducted once degradation/age milestone occurs

20-year qualified life			
Sequence	**Equivalent Years**	**24 hr cells**	**72 hr cells**
Test performed before aging	0 (Baseline)	MP	MP
	0 (Acceptance)	MP	MP
Test performed after aging	2	MP	MP
	4	MP	MP
	6	MP	MP
	8	MP	MP
	10	MP	MP
	12	MP	MP
	14	MP	MP
	16	MP	MP
	18	MP*	MP*
	19	MP	MP
	20	MP	MP
	21	MP	MP
	22	Note 1	Note 1
Test performed after abnormal environmental conditions cycling		MP	MP
Test performed after seismic test and HRHF screening test		MP	MP

Table 3-1: Thermal Aging and Cycling Sequence

* At any time if degradation is shown such that the capacity < 100% of manufacturer's rating or when the battery reaches 85% of the expected life, a modified performance test will be conducted annually (equivalent years).

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AP1000 24Hr and 72Hr Batteries

Test Plan envelops worst case for cells because it assumes the cells have degraded at 85% of their life triggering annual testing (not all cells will degrade at that rate)

Test Plan is more conservative than the requirement of the AP1000 Tech Specs and IEEE Std 450

Test Plan is more conservative because modified performance test including duty cycle is conducted as opposed to a performance test alone

AP1000 24Hr and 72Hr Batteries

Licensing / Regulatory Compliance

- Battery environmental and seismic qualification approach meets the intent of IEEE Std 323-1974, IEEE Std 344-1987 and IEEE Std 535-1986
- Battery qualification testing will be in accordance with IEEE Std 535-1986 with a change to a longer duration Type 3 modified performance test vs. the required 3 hour performance test after seismic test and age conditioning included in program
- No changes have been made that would affect battery qualification since Rev 15 of DCD

AP1000 24Hr and 72Hr Batteries

Cycling Degrades Batteries

- Active material could be reduced resulting in reduced capacity leading to failure or premature ending of test program
- Annual service testing coupled with 5 year performance testing is less rigorous and less conservative
- Service testing (annual or otherwise) does not provide any information on the capacity of the battery
- Modified performance tests will provide data points every 2 years on the capacity of the battery

AP1000 24Hr and 72Hr Batteries

Summary

- Westinghouse environmental and seismic qualification test program for AP1000 24hr and 72hr Class 1E 250 VDC Batteries is in compliance with regulatory and industry requirements
- The program has been developed to meet and exceed the guidance IEEE Std 535-1986
- Westinghouse test plan for 24hr and 72hr Class 1E 250 VDC Batteries will be used by vendors in qualification of their batteries for the AP1000 project