Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-19-056

June 7, 2019

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 1
Facility Operating License No. NPF-90
Docket No. 50-390

Watts Bar Nuclear Plant, Unit 2
Facility Operating License No. NPF-96
Docket No. 50-391

Subject: **Response to NRC Request for Additional Information Regarding Application to Revise Technical Specifications Regarding DC Electrical Systems TSTF-500, Revision 2, "DC Electrical Rewrite - Update to TSTF-360 (WBN-TS-18-09) (EPID L-2018-LLA-0494)**

References:
1. TVA letter to NRC, CNL-18-118, "Application to Revise Technical Specifications Regarding DC Electrical Systems TSTF-500, Revision 2, 'DC Electrical Rewrite - Update to TSTF -360' (WBN-TS-18-09)," dated November 29, 2018 (ML18334A389)
2. NRC Electronic Mail to TVA, "Watts Bar Nuclear Plant - Final Request for Additional Information Related to Application to Revise Technical Specifications Regarding DC Electrical Systems TSTF-500, Revision 2 (EPID L-2018-LLA-0494)" dated May 3, 2019 (ML19011A349)

In Reference 1, TVA submitted a request for an amendment to the technical specifications (TS) for Watts Bar Nuclear Plant (WBN), Units 1 and 2.

The proposed amendment revises TS requirements related to direct current (DC) electrical systems in accordance with Technical Specification Task Force (TSTF) Traveler TSTF-500, Revision 2, "DC Electrical Rewrite - Update to TSTF-360." In Reference 2, NRC issued a Request for Additional Information (RAI) and requested TVA respond by June 7, 2019. Enclosure 1 to this letter provides the response to the RAI. As noted in Enclosure 1, the response to this RAI necessitates changes to the proposed TS 3.8.4 and 3.8.6 in Reference 1. Accordingly, Enclosure 2 provides markups of the existing TS and Bases pages to show the proposed changes. Enclosure 3 provides revised (clean) TS pages. The proposed TS changes in Enclosures 2 and 3 supersede the corresponding TS provided in Reference 1.

The enclosures to this letter do not change the no significant hazard considerations or the environmental considerations contained in Reference 1. Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and the enclosure to the Tennessee Department of Environment and Conservation.

Enclosure 4 contains the revised regulatory commitment associated with this submittal that supersedes the commitment provided in Reference 1. Please address any questions regarding this request to Kimberly D. Hulvey at (423) 751-3275.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 7th day of June 2019.

Respectfully,

Erin K. Henderson
Director, Nuclear Regulatory Affairs

Enclosures:

1. Response to NRC Request for Additional Information Regarding License Amendment Request to Revise Technical Specifications to Adopt Technical Specifications Task Force (TSTF) -500, Revision 2, "DC Electrical Rewrite – Update to TSTF-360" Docket Nos. 50-390 and 50-391
2. Markups of Technical Specifications and Bases Changes
3. Clean Technical Specifications and Bases Changes
4. Revised Regulatory Commitment

cc (Enclosures):

NRC Regional Administrator – Region II
NRC Project Manager – Watts Bar Nuclear Plant
NRC Senior Resident Inspector – Watts Bar Nuclear Plant
Director, Division of Radiological Health – Tennessee State Department of Environment and Conservation

Response to NRC Request for Additional Information Regarding License Amendment Request to Revise Technical Specifications to Adopt Technical Specifications Task Force (TSTF) -500, Revision 2, "DC Electrical Rewrite – Update to TSTF-360"
Docket Nos. 50-390 and 50-391

INTRODUCTION

By letter dated November 29, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession number ML18334A389), Tennessee Valley Authority (TVA, the licensee), requested an amendment to Facility Operating Licenses NPF-90 and NPF-96 for Watts Bar Nuclear Plant (WBN), Units 1 and 2. The proposed license amendment request would revise the WBN Units 1 and 2 TS to adopt the Nuclear Regulatory Commission (NRC)-approved Technical Specifications Task Force (TSTF)-500, Revision 2, "DC [direct current] Electrical Rewrite – Update to TSTF-360." Specifically, the licensee proposed changes to the TS requirements related to DC electrical power systems in TS 3.8.4, "DC sources – Operating," TS 3.8.5, "DC Sources – Shutdown," and TS 3.8.6, "Battery Cell Parameters." Additionally, the licensee proposed to add to the TS Section 5.7, "Procedures, Programs, and Manuals," a new program titled "Battery Monitoring and Maintenance Program."

The Electrical Engineering Operating Branch (EEOB) staff has determined that the following additional information is needed to complete the review of the WBN license amendment request (LAR).

Regulatory Requirements

Title 10 of the Code of Federal Regulations, Part 50 (10 CFR 50), Section 36, "Technical Specifications," requires, in part, that the operating license of a nuclear production facility include TS. 10 CFR 50.36 (c)(2) requires that the TS include limiting conditions for operation (LCOs) which are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When an LCO of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met.

10 CFR 50, Appendix A, General Design Criterion (GDC) 17, "Electric power systems," states, in part, that "an onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety.… The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure."

Regulatory Guidance

TSTF-500, Revision 2, "DC Electrical Rewrite – Update to TSTF-360," dated September 22, 2009 (ADAMS Accession No. ML092670242).

EEOB RAI -1

The licensee proposed a new TS 3.8.4 Condition A with associated Required Actions and Completion Time for the required vital battery charger(s).

Condition A would state:

Condition A	*One or two required vital battery charger (s) on one subsystem inoperable*

Required Actions A.1, A.2, and A.3 would state:

Required Action A.1	*Restore battery terminal voltage to greater than or equal to the minimum established float voltage.*
Completion Time	*2 hours*
AND	
Required Action A.2	*Verify battery float current ≤ 2 amps.*
Completion Time	*Once per 12 hours*

In Enclosure 4 of the LAR, the licensee provided a commitment to include in the WBN updated safety analysis report (UFSAR) "a requirement to maintain a 2 percent design margin for the vital batteries which corresponds to a 2 amp float current value being used as an indication that the battery is at least 98 percent charged."

In Enclosure 6 of the LAR, the licensee stated that the "normal recharging of the battery from the design discharged condition can be accomplished in approximately 12 hours (with accident loads being supplied) following a 30-minute AC power outage and in approximately 36 hours (with normal loads being supplied) following a 4-hour AC power outage."

The NRC has identified the following discrepancies:

The 2-amp float current value for the vital batteries provides an indication that the batteries are less than 100 percent charged. It does not appear that a discussion about how the 2 percent design margin would ensure that the vial batteries would be 100 percent charged at a 2-amp float current was provided.

It appears that it could take longer than 12 hours to fully recharge a vital battery that would be discharged for a period longer than 30 minutes before connecting the spare charger.

The staff requests the following information to address these discrepancies:

a) *Explain how maintaining a "2 percent design margin … as an indication that the battery is at least 98 percent charged" will ensure that the WBN vital batteries are fully charged (i.e., capable of performing their design function).*

b) *Provide a discussion to demonstrate that the vital battery can be fully recharged in 12 hours from Condition A after a 2-hour discharge (i.e., the time allowed by Required Action A.1 to place the spare charger on the battery).*

TVA Response to EEOB RAI -1

a) TVA has verified, via the battery manufacturer, that a charging current less than or equal to two amps (A) is an indication that the battery is at least 98 percent charged. Therefore, maintaining an additional two percent design margin in the WBN battery sizing calculation is needed to ensure that 100 percent battery capacity is available once charging current is 2 A or less. This is equivalent to the battery being 100 percent charged, because the sizing calculation ensures that the battery can perform its safety related function during a design bases event.

b) The time to return the battery to its fully charged condition is a function of the battery charger capacity, the amount of loads on the associated direct current (DC) system, the amount of the previous discharge, and the recharge characteristic of the battery. Total normal steady state loads on the battery chargers average less than 100 A based on walk down data. Each vital battery is rated for 2320 A-hours. Each battery charger is rated for 200 A.

200 A available - 100 A steady state load = 100 A excess capacity for battery charging.

Assuming the battery charger is offline for two hours (the time allowed by TSTF-500 to place a charger on the battery) and assuming normal steady state DC system loads remain on battery during this time would equate to a two hour x 100 A (or 200 A-hour) loss. Assuming 110 percent of 200 A-hour (or 220 A-hour) would be required to restore the battery to a fully recharged state and given the 100 A excess battery charger capacity above, the battery can be restored to fully recharged within:

220 A-hour / 100 A = 2.2 hours.

However, because the battery chargers are constant voltage chargers rather than constant current chargers, it is recognized that the battery charging current will taper off from the initial maximum current that the charger can supply to a final value of less than 2 A. TVA does not possess battery recharge current characteristic curves, but it is considered reasonable to expect that the battery would be fully recharged in less than 12 hours to less than 2 A charging current, given the above charger capacity and relatively small amount of capacity removed from the batteries.

EEOB RAI-2

The licensee proposed a new TS 3.8.4 Condition D with associated Required Actions and Completion Time for the diesel generator (DG) battery charger(s).

Condition D would state:

Condition D	*One DG DC battery charger inoperable*

Required Actions D.1, D.2, and D.3 would state:

Required Action D.1	*Restore DG battery terminal voltage to greater than or equal to the minimum established float voltage.*
Completion Time	*2 hours*

AND
Required Action D.2 — *Verify battery float current ≤ 1 amp.*
Completion Time — *Once per 12 hours*
AND
Required Action D.3 — *Restore DG battery charger to OPERABLE status*
Completion Time — *72 hours*

In Enclosure 4 of the LAR, the licensee provided a commitment to include in the WBN UFSAR "a requirement to maintain a 2 percent design margin for the DG batteries which corresponds to a 1 amp float current value being used as an indication that the battery is at least 98 percent charged."

The NRC has identified the following discrepancies:

The 1-amp float current value for the DG batteries provides an indication that the DG batteries are less than 100 percent charged. It does not appear that a discussion about how the 2 percent design margin would ensure that the vial batteries would be 100 percent charged at a 2-amp float current was provided.

The 12-hour and 72-hour completion times for verifying battery float current and for restoring the battery to operable status, respectively, are bracketed in the TSTF-500. It does not appear that the bases for the proposed 12 hours and 72 hours for Required Actions D.2 and D.3, respectively, were provided.

The staff requests the following information to address these discrepancies:

a) Explain how maintaining a "2 percent design margin … as an indication that the battery is at least 98 percent charged" will ensure that the WBN DG batteries are fully charged (i.e., capable of performing their design function).

b) Provide the WBN basis for the 12-hour and the 72-hour completion times for Required Actions D.2 and D.3, respectively.

<u>TVA response to EEOB RAI -2</u>

a) TVA has verified via the DG battery manufacturer that a charging current less than or equal to 1 A is an indication that the battery is at least 98 percent charged. Therefore, maintaining an additional 2 percent design margin in the WBN battery sizing calculation is needed to ensure that 100 percent battery capacity is available once charging current is 1 A or less. This is equivalent to the battery being 100 percent charged, because the sizing calculation ensures that the battery can perform its safety related function during a design bases event.

b) The 12-hour time to return the DG battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DG DC system, the amount of the previous discharge, and the recharge characteristic of the battery. Typical normal steady state loads on a DG battery charger is 10.41 A, based on pre-operational testing of DG battery charger 2B-B. Each DG battery is rated for 192 A-hours. Each battery charger is rated for 20 A.

20 A available – 10.41 A steady state load = 9.59 A excess capacity for battery charging.

Assuming the battery charger is offline for two hours (the time allowed by TSTF-500 to place a charger on the battery) and assuming normal steady state DG DC system loads remain on battery during this time would equate to a two hour x 10.41 A (or 20.82 A-hour) loss. Assuming 110 percent of 20.82 A-hour (or 22.90 A-hour) would be required to restore the battery to a fully recharged state and given the 9.59 A excess battery charger capacity above, the battery can be restored to fully recharged within:

22.90 A-hour / 9.59 A = 2.39 hours.

However, because the battery chargers are constant voltage chargers rather than constant current chargers, it is recognized that the battery charging current will taper off from the initial maximum current that the charger can supply to a final value of less than 1 A. TVA does not possess battery recharge current characteristic curves, but it is considered reasonable to expect that the battery would be fully recharged in less than 12 hours to less than 1 A charging current, given the above charger capacity and relatively small amount of capacity removed from the batteries.

The 72-hour completion time for the DG batteries is consistent with the 72-hour completion time for TS 3.8.4, Required Action A.3, and TS 3.8.5, Required Action A.3 in TSTF-500. As noted in TSTF-500, the 72-hour completion time must be adopted unless a licensee wishes to adopt a longer completion time. Furthermore, the 72 hours will allow, in many cases, a sufficient period of time to correct a charger problem. The 72-hour completion time is also commensurate with the importance of maintaining the DG DC system's capability to adequately respond to a design basis event.

EEOB RAI-3

The licensee proposed to revise SR 3.8.4.12 and renumber it as SR 3.8.4.6.

Renumbered SR 3.8.4.6 would state:

SR 3.8.4.6	*-----------------------------------NOTE------------------------------------* *Credit may be taken for unplanned events that satisfy this SR.* *---* *Verify each DG battery charger supplies ≥ 20 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours.* *<u>OR</u>* *Verify each DG battery charger can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.*

The NRC staff notes that a discussion about the basis for the proposed 4 hours and 24 hours testing durations in the renumbered SR 3.8.4.6 was not provided.

Explain the basis for the proposed 4 hours and 24 hours testing durations for the WBN DG battery chargers.

<u>TVA Response to EEOB RAI-3</u>

Current TS SR 3.8.4.12 requires verification every 18 months that each DG battery charger is capable of recharging the associated battery from a service or capacity discharge test while supplying normal loads. TVA has decided to not adopt the TSTF-500 SR option to verify that each DG battery charger supplies ≥ 20 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours. Verifying that each DG battery charger is capable of recharging the associated battery from a service or capacity discharge test while supplying normal loads is sufficient to verify the operability of the battery charger. Enclosures 2 and 3 provide the revised Technical Specifications (TS) and Bases to reflect this change.

Regarding the basis for the 24-hour testing duration for the DG batter chargers, the WBN battery sizing calculations for the DG batteries indicate that the battery chargers are capable of fully charging the batteries within 24 hours, while simultaneously supporting the connected loads.

Similar to the response to EEOB RAI-2b, the time to return the DG battery to its fully charged condition is a function of the battery charger capacity, the amount of loads on the associated DG DC system, the amount of the previous discharge, and the recharge characteristic of the battery. Typical normal steady state loads on a DG battery charger is 10.41 A, based on pre-operational testing of DG battery charger 2B-B. Each battery charger is rated for 20 A.

20 A available – 10.41 A steady state load = 9.59 A excess capacity for battery charging.

The duty cycle for the DG batteries is based on the batteries supplying DG loads without benefit of chargers for four hours during a station blackout (SBO) event. The duty cycle of the DG batteries for a SBO event is approximately 66.5 A hours. Therefore, recharging the DG battery would equate to 66.5 A-hours / 9.59 A = 6.93 hours (assuming the battery is completely discharged and assuming normal steady state DG DC system loads remain on battery during this time).

Assuming 110 percent of DG battery capacity of 66.50 A-hour (or 73.15 A-hour) would be required to restore the battery to a fully recharged state and given the 9.59 A excess battery charger capacity above, the battery can be restored to fully recharged within:

73.15 A-hours / 9.59 A = 7.63 hours.

However, because the battery chargers are constant voltage chargers rather than constant current chargers, it is recognized that the battery charging current will taper off from the initial maximum current that the charger can supply to a final value of less than 1 A. TVA does not possess battery recharge current characteristic curves, but it is considered reasonable to expect that the battery would be fully recharged in less than 24 hours to less than 1 A charging current, given the above charger capacity and relatively small amount of capacity removed from the batteries.

EEOB RAI-4

In Enclosure, Section 1.0 of the LAR, the licensee proposed relocating the Technical Specification (TS) Table 3.8.6-1, "Battery Surveillance Requirements," to the proposed Battery Monitoring and Maintenance Program in TS 5.7. The Table 3.8.6-1 includes Category A, B, and C limits for the battery cell parameters (i.e., electrolyte level, float voltage, specific gravity).

Confirm that the battery cell parameters (electrolyte level, float voltage, specific gravity) will continue to be controlled at their current Categories A, B, and C levels in the TS Battery Monitoring and Maintenance Program, and that actions to restore deficient values will be implemented in accordance with the licensee's corrective action program.

TVA Response to EEOB RAI-4

TVA confirms that the battery cell parameters (electrolyte level, float voltage, specific gravity) will be relocated to the Battery Monitoring and Maintenance Program at their current Categories A, B, and C levels. The battery cell parameters within the program will be controlled consistent with IEEE 450-2002, as specified in proposed TS 5.7.2.22, "Battery Monitoring and Maintenance Program." Actions to restore deficient values of any of the battery cell parameters specified in the program will be tracked and implemented in accordance with the TVA corrective action program.

EEOB RAI-5

The proposed new TS 3.8.6 Condition A would apply when one DG battery is found with one or more battery cell(s) with a float voltage of less than 2.07 volts (V).

The NRC staff notes that the 2.07-V for the battery cell float voltage is bracketed in TSTF-500. It does not appear that the basis for the proposed 2.07-V limit for the WBN DG battery cell float voltage was provided.

Explains the WBN basis for the 2.07-V limit for the WBN DG battery cell float voltage.

TVA Response to EEOB RAI-5

The 2.07 volt limit is consistent with the most limiting float voltage limit in WBN TS Table 3.8.6-1, "Battery Cell Parameters Requirements." The WBN battery cells are of the vented lead-acid type with a nominal electrolyte specific gravity of 1.215. Open circuit voltage of the lead-acid battery cell is related to the specific gravity by a constant as shown in the following:

Open Circuit Voltage = Specific Gravity + 0.845

Therefore, for the WBN battery cells, the nominal cell open circuit voltage is 1.215 + 0.845 = 2.06 volts DC. A cell voltage of less than or equal to cell open circuit voltage indicates the cell is no longer being floated at a voltage sufficient to prevent discharge.

EEOB RAI-6

The licensee proposed adding a new TS 3.8.6 Condition F which would apply to one or two required vital battery (ies) on one subsystem or one DG battery found with a pilot cell electrolyte temperature less than the minimum established design limits. The Required Action F.1 would restore the pilot cell electrolyte temperature to greater than or equal to minimum established design limits within 12 hours.

In Enclosure 1 of the LAR, the licensee states: "TVA verifies that battery room temperature is routinely monitored such that a room temperature excursion could reasonably expect to be detected and corrected prior to the average battery electrolyte temperature dropping below the minimum electrolyte temperature."

Regarding the selection of pilot cells, the TSTF-500 states:

> *Previously, average battery temperature was monitored instead of pilot cell temperature. As a result, temperature was not a criterion with selecting a pilot cell. In order to use pilot cell temperature instead of the average battery temperature, temperature must be used as a criterion when selecting the pilot cell. […] For batteries where it could be shown that the maximum temperature deviation across the battery did not exceed the IEEE 450 recommended maximum of 5°F [degrees Fahrenheit], the NRC has accepted that the cell temperature was not a critical parameter. Therefore, for these batteries, cell temperature did not have to be taken into account when selecting pilot cells.*

The NRC has identified the following discrepancies:

It appears that a discussion about the frequency of monitoring the battery room and how the battery room temperature would be restored if it was outside the temperature design limits was not provided.

It appears that a discussion about the selection of the WBN battery pilot cell based on temperature was not provided.

The staff requests the following information to address these discrepancies:

a) *Provide a discussion about how the vital and DG battery rooms temperatures are monitored at WBN and provide the minimum frequencies at which the temperatures are monitored. Also explain how the licensee would restore the vital and DG battery rooms' temperatures if they were outside the temperature design limits.*

b) *Provide a discussion about the selection of the battery pilot cell based on temperature. If the temperature will not be used as a criterion for selecting battery pilot cells, provide an analysis of temperature deviations for the WBN batteries based on operation experience to show that the maximum temperature deviation across the batteries does not exceed the IEEE 450 recommended maximum of 5°F.*

TVA Response to EEOB RAI-6

a) The temperatures of the vital battery rooms and DG battery rooms are monitored once per shift (12 hours) by Operations personnel. This satisfies Technical Requirement Manual (TRM) Surveillance Requirement (TSR) 3.7.5.1 to verify each area temperature is within limits every 12 hours. The room temperatures are documented in the applicable Shift and Daily Surveillance Log and verified to be in compliance with TSR 3.7.5. For the vital battery rooms, the Auxiliary Building heating, ventilation, and air conditioning (HVAC) is designed to maintain the room temperature and relative humidity within the environmental design limits. The Auxiliary Building HVAC operating procedures include compensatory actions for coping with and recovery from loss of train cooling so that design temperatures for the area are not exceeded. For the DG batteries, the DG building ventilation system is design to maintain temperatures within the limits of the environmental design criteria. Should the battery room temperatures approach temperature limits specified in TR 3.7.5, operations would employ existing HVAC features to improve room temperatures. DG room dampers may be closed to isolate outside air or fans can be energized to circulate air. Should design features fail to provide the needed heating or cooling, the site could proceed with temporary equipment installation or DG operation, if increasing room temperature is warranted.

b) WBN's current vital and DG battery surveillance performance practices and a review of actual electrolyte temperature deviations for these batteries demonstrates compliance with the IEEE 450 recommended maximum temperature deviation of 5°F. Current WBN weekly surveillance instructions identify the basis for pilot cell section is based on voltage and specific gravity parameters, because cell temperatures are typically maintained within ±3° F. The review of actual quarterly battery surveillance data since 2014 for the five vital batteries included 12 cells per battery for approximately 20 tests with a total of 100 tests reviewed. All recorded vital battery electrolyte temperatures were within the IEEE 450 recommended maximum of 5°F. The review of actual quarterly battery surveillance data since 2014 for the four DG batteries included 12 cells per battery for approximately 21 tests with a total of 84 tests reviewed. The tests were conducted at various times of the year, which is representative of the full range of ambient temperatures the DG rooms are subjected to. The recorded DG battery electrolyte temperatures were within the IEEE 450 recommended maximum of 5° F. This data supports that the maximum temperature deviation across the vital and DG batteries does not exceed the IEEE 450 recommended maximum of 5° F. This is consistent with the IEEE 450 recommendations for determining that cell temperature is not a critical parameter for selection of pilot cells. Therefore, the vital and DG battery pilot cells will not be chosen based on temperature.

EEOB RAI-7

The licensee proposed a new TS 3.8.6 Condition G out-of-limit parameters for batteries in redundant subsystems based on the TSTF-500 TS 3.8.6 Condition E for NUREG-1431, "Standard Technical Specifications Westinghouse Plants," Revision 1.

WBN TS 3.8.6 Condition G and associated Required Action G.1 would state:

Condition G	*One or more batteries in redundant subsystems with battery parameters not within limits.* *OR* *More than one DG battery with battery parameters not within limits.*

Required Action G.1 *Restore battery parameters to within limits.*
Completion Time *2 hours*

The NRC has identified the following discrepancies:

The first option of the proposed Condition G did not specify the type of batteries which the condition pertains to.

The Required Action E.1 in TSTF-500 restores the parameters for the batteries in one subsystem whereas the proposed Required Action G.1 would restore the parameters for all batteries [in the redundant (both) subsystems].

a) *Clarify the type of batteries that would be addressed in in the first option condition of the proposed TS 3.8.6 Condition G.*

b) *Explain the basis for deviating from the TSTF-500 Required Action for restoring the parameters for the batteries in one subsystem.*

TVA Response to EEOB RAI-7

a) TS 3.8.6, Condition G, is being revised to indicate that the first option applies to the vital batteries. See the revised TS and Bases in Enclosures 2 and 3.

b) TS 3.8.6, Condition G and associated Required Actions, for vital batteries are being revised to be consistent with TSF-500. Because the DG batteries support DGs that are arranged in trains (i.e., DG 1A-A and 2A-A are in Train A, and DG 1B-B and 2B-B are in Train B), a new condition (Condition H) has been added to address multiple DG batteries in redundant trains with parameters not within limits. The required actions are consistent with TSTF-500, in that they require the restoration of the DG batteries in one train to within limits in 2 hours. This will ensure that the DG batteries either can support the operation of one train of DGs or are declared inoperable. Subsequent conditions have been re-lettered accordingly.

   Consistent with the above change, changes are being made to TS 3.8.4, Condition D, so that the condition applies to one or two inoperable DG battery chargers in one train. The wording of TS 3.8.4, Condition E, is being changed from referring to DG DC subsystem to referring to a DG DC train to be consistent with the terminology used for the arrangement of the DGs. See the revised TS and Bases in Enclosures 2 and 3.

   Each DG DC electrical power system is independent and dedicated to its respective DG. The DGs that are supported by the DG DC electrical power systems are arranged in redundant trains (i.e., DG 1A-A and DG 2A-A are in Train A, and DG 1B-B and DG 2B-B are in Train B). When one or two DGs in a train are inoperable, that train of standby electrical power is incapable of performing the safety function and must rely on the redundant DG train to mitigate an event. Likewise, if one or two of the DG DC trains that support the DGs in that train are inoperable, that train of standby electrical power is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Therefore, the LCO requires Train A and Train B DG DC electrical power subsystems to be OPERABLE to support the redundancy of the standby electrical power system.

EEOB RAI-8

In Enclosure 4 of the LAR, the licensee provided a commitment to verify that plant procedures will require verification of the selection of the pilot cell or cells when performing SR 3.8.6.5. The proposed new SR 3.8.6.5 would verify that each required vital battery and each DG battery pilot cell temperature is greater than or equal to minimum established design limits.

The NRC staff notes that the verification of the selection of the pilot cell or cells should be done when performing the SR that verifies the battery connected cell float voltage, as stated in the TSTF-500.

Provide the justification for deviating from the TSTF-500 with respect to the verification of the selection of the pilot cell during the SR for battery cell float voltage.

TVA Response to EEOB RAI-8

TVA is providing a corrected commitment to verify that plant procedures will require verification of the selected battery pilot cell during performance of SR 3.8.6.6 (verification of battery cell float voltage), consistent with TSTF-500. This commitment supersedes the commitment provided in the referenced LAR to verify that plant procedures will require verification of the selected battery pilot cell during performance of SR 3.8.6.5. The revised commitment is provided in Enclosure 4. The revised commitment also corrects the title of the reference to TS 5.7, “Procedures, Programs, and Manuals.”

Reference

TVA letter to NRC, CNL-18-118, “Application to Revise Technical Specifications Regarding DC Electrical Systems TSTF-500, Revision 2, ‘DC Electrical Rewrite - Update to TSTF -360’ (WBN-TS-18-09),” dated November 29, 2018 (ML18334A389)

Enclosure 2

Markups of Technical Specification and Bases Changes

WBN Unit 1 Markups of Technical Specification and Bases

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources - Operating

LCO 3.8.4 Four channels of The Train A and Train B vital DC and four Diesel Generator (DG) DC electrical power subsystems shall be OPERABLE.

---NOTES---

1. Vital Battery V may be substituted for any of the required vital batteries.

2. The C-S DG and its associated DC electrical power subsystem may be substituted for any of the required DGs and their associated DC electrical power subsystem.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery charger(s) on one subsystem inoperable.	A.1 Restore battery terminal voltage to greater than or equal to the minimum established float voltage.	2 hours
	AND	
	A.2 Verify battery float current ≤ 2 amps.	Once per 12 hours
	AND	
	A.3 Restore vital battery charger(s) to OPERABLE status.	7 days
AB. One vital DC electrical power subsystem inoperable for reasons other than Condition A.	AB.1 Restore vital DC electrical power subsystem to OPERABLE status.	2 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
BC. Required Action and Associated Completion Time of Condition A or B not met.	BC.1 Be in MODE 3. AND BC.2 Be in MODE 5.	6 hours 36 hours
D. One or two DG DC battery charger(s) on one train inoperable.	D.1 Restore DG battery terminal voltage to greater than or equal to the minimum established float voltage. AND D.2 Verify battery float current ≤ 1 amp. AND D.3 Restore DG battery charger(s) to OPERABLE status.	2 hours Once per 12 hours 72 hours
CE. One DG DC electrical power subsystem train inoperable for reasons other than Condition D.	CE.1 Restore DG DC electrical power subsystem train to OPERABLE status.	2 hours
DF. Required Action and associated Completion Time of Condition CD or E not met.	DF.1 Declare associated DG inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify vital battery terminal voltage is ~~≥ 128 V (132 V for vital battery V) on float charge~~ greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.2	Verify DG battery terminal voltage is ~~≥ 124 V on float charge~~ greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.3	Verify for the vital batteries that the alternate feeder breakers to each required battery charger are open.	7 days
SR 3.8.4.4	Verify correct breaker alignment and indicated power availability for each DG 125 V DC distribution panel and associated battery charger.	7 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
~~SR 3.8.4.5~~	~~Verify no visible corrosion at terminals and connectors for the vital batteries.~~ ~~OR~~ ~~Verify connection resistance for the vital batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 ohm for inter-rack connections, ≤ 120 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~92 days~~
~~SR 3.8.4.6~~	~~Verify no visible corrosion at terminals and connectors for the DG batteries.~~ ~~OR~~ ~~Verify connection resistance for the DG batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~92 days~~
~~SR 3.8.4.7~~	~~Verify battery cells, cell plates, and racks show no visual indication of physical damage or abnormal deterioration.~~	~~12 months~~
~~SR 3.8.4.8~~	~~Remove visible terminal corrosion and verify battery cell to cell and terminal connections are coated with anti-corrosion material.~~	~~12 months~~

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
~~SR 3.8.4.9~~	~~Verify connection resistance for the vital batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 for inter-rack connections, ≤ 120 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~12 months~~
~~SR 3.8.4.10~~	~~Verify connection resistance for the DG batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~12 months~~
SR 3.8.4.~~11~~5	~~-----------------------------NOTE-----------------------------~~ ~~This Surveillance is normally not performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR.~~ ~~---~~ Verify each vital battery charger ~~is capable of recharging its associated battery from a service or capacity discharge test while supplying normal loads~~ supplies ≥ 200 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours. OR Verify each vital battery charger ~~is capable of operating for ≥ 4 hours at current limit 220 - 250 amps~~ can recharge the battery to the fully charged state within 36 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.~~12~~6	------------------------------NOTE------------------------------ Credit may be taken for unplanned events that satisfy this SR. -- Verify each ~~diesel generator~~ DG battery charger ~~is capable of recharging its associated battery from a service or capacity discharge test while supplying normal loads~~ can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months
SR 3.8.4.~~13~~7	-----------------------------NOTES----------------------------- 1. The modified performance discharge test in SR 3.8.~~4.14~~6.7 may be performed in lieu of the service test in SR 3.8.4.~~13~~7 ~~once per 60 months~~. 2. This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. -- Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads and any connected nonsafety loads for the design duty cycle when subjected to a battery service test.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
~~SR 3.8.4.14~~	~~-----------------------------NOTES-----------------------------~~ ~~This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR.~~ ~~---~~ ~~Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.~~	~~60 months~~ ~~AND~~ ~~12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating~~ ~~AND~~ ~~24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating~~

3.8 ELECTRICAL POWER SYSTEMS

3.8.6 Battery ~~Cell~~ Parameters

LCO 3.8.6 Battery ~~cell~~ parameters for Train A and Train B electrical power subsystem 125 V vital batteries and 125 V diesel generator (DG) batteries shall be within ~~the~~ limits ~~of Table 3.8.6-1~~.

APPLICABILITY: When associated DC electrical power subsystems and DGs are required to be OPERABLE.

ACTIONS

-----------------------------------NOTE-----------------------------------
Separate Condition entry is allowed for each battery bank.

~~CONDITION~~	~~REQUIRED ACTION~~	~~COMPLETION TIME~~
~~A. One or more batteries with one or more battery cell parameters not within Category A or B limits.~~	~~A.1 Verify pilot cells electrolyte level and float voltage meet Table 3.8.6-1 Category C limits.~~	~~1 hour~~
	~~AND~~	
	~~A.2 Verify battery cell parameters meet Table 3.8.6-1 Category C limits.~~	~~24 hours~~ ~~AND~~ ~~Once per 7 days thereafter~~
	~~AND~~	
	~~A.3 Restore battery cell parameters to Category A and B limits of Table 3.8.6-1.~~	~~31 days~~

~~(continued)~~

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V.	A.1 Perform SR 3.8.4.1.	2 hours
	AND	
	A.2 Perform SR 3.8.6.1.	2 hours
	AND	
	A.3 Restore affected cell voltage ≥ 2.07 V.	24 hours
B. One or two required vital battery(ies) on one subsystem with float current > 2 amps.	B.1 Perform SR 3.8.4.1.	2 hours
	AND	
	B.2 Restore vital battery float current to ≤ 2 amps.	12 hours
C. One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V.	C.1 Perform SR 3.8.4.2.	2 hours
	AND	
	C.2 Perform SR 3.8.6.2.	2 hours
	AND	
	C.3 Restore affected cell voltage ≥ 2.07 V.	24 hours
D. One or two DG battery(ies) on one train with float current > 1 amp.	D.1 Perform SR 3.8.4.2.	2 hours
	AND	
	D.2 Restore vital battery float current to ≤ 1 amp.	12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
-----NOTE----- Required Action E.2 shall be completed if electrolyte level was below the top of plates. ----------	-----NOTE----- Required Actions E.1 and E.2 are only applicable if electrolyte level was below the top of plates. ----------	
E. One or two required vital battery(ies) on one subsystem with one or more cells electrolyte level less than minimum established design limits. OR One or two DG battery(ies) on one train with one or more cells electrolyte level less than minimum established design limits.	E.1 Restore electrolyte level to above top of plates. AND E.2 Verify no evidence of leakage. AND E.3 Restore electrolyte level to greater than or equal to minimum established design limits.	8 hours 12 hours 31 days
F. One or two required vital battery(ies) on one subsystem with pilot cell electrolyte temperature less than minimum established design limits. OR One or two DG battery(ies) on one train with pilot cell electrolyte temperature less than minimum established design limits.	F.1 Restore battery pilot cell temperature to greater than or equal to minimum established design limits.	12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. One or more vital batteries in redundant subsystems with battery parameters not within limits.	G.1 Restore battery parameters for vital batteries in one subsystem to within limits.	2 hours
H. One or more DG batteries in redundant trains with battery parameters not within limits.	H.1 Restore battery parameters for DG batteries in one train to within limits.	2 hours

ACTIONS (continued)

CONDITION		REQUIRED ACTION		COMPLETION TIME
BI.	Required Action and associated Completion Time of Condition A, B, C, D, E, F, G, or H not met. OR One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V and float current > 2 amps. OR One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V and float current > 1 amp. One or more batteries with average electrolyte temperature of the representative cells < 60°F for vital batteries and < 50°F for DG batteries. OR One or more batteries with one or more battery cell parameters not within Category C values.	BI.1	Declare associated battery inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	Verify battery cell parameters meet Table 3.8.6-1 Category A limits.	7 days
SR 3.8.6.2	Verify battery cell parameters meet Table 3.8.6-1 Category B limits.	92 days AND Once within 24 hours after a battery discharge < 110 V for vital batteries (113.5 V for vital battery V) or 106.5 V for DG batteries AND Once within 24 hours after a battery overcharge > 150 V for vital batteries (155 V for vital battery V) or 145 V for DG batteries
SR 3.8.6.3	Verify average electrolyte temperature of representative cells is ≥ 60°F for vital batteries and ≥ 50°F for the DG batteries.	92 days

Insert Surveillance Requirements from next page.

Insert the following Surveillance Requirements for LCO 3.8.6:

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	------------------------------NOTE-------------------------------- Not required to be met when vital battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. -- Verify each vital battery float current is ≤ 2 amps.	7 days
SR 3.8.6.2	------------------------------NOTE-------------------------------- Not required to be met when DG battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. -- Verify each DG battery float current is ≤ 1 amp.	7 days
SR 3.8.6.3	Verify each required vital battery and each DG battery pilot cell float voltage is ≥ 2.07 V.	31 days
SR 3.8.6.4	Verify each required vital battery and each DG battery connected cell electrolyte level is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.5	Verify each required vital battery and each DG battery pilot cell temperature is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.6	Verify each required vital battery and each DG battery connected cell float voltage is ≥ 2.07 V.	92 days

SURVEILLANCE		FREQUENCY
SR 3.8.6.7	-----------------------------NOTES----------------------------- This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --- Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.	60 months AND 12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating AND 24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating

Table 3.8.6-1 (page 1 of 1)
Battery Cell Parameters Requirements

PARAMETER	CATEGORY A: LIMITS FOR EACH DESIGNATED PILOT CELL	CATEGORY B: LIMITS FOR EACH CONNECTED CELL	CATEGORY C: ALLOWABLE LIMIT FOR EACH CONNECTED CELL
Electrolyte Level	> Minimum level indication mark, and ≤ 1/4 inch above maximum level indication mark (a)	> Minimum level indication mark, and ≤ 1/4 inch above maximum level indication mark (a)	Above top of plates, and not overflowing
Float Voltage	≥ 2.13 V	≥ 2.13 V	> 2.07 V
Specific Gravity (b)(c)	≥ 1.200	≥ 1.195 AND Average of all connected cells > 1.205	Not more than 0.020 below average of all connected cells AND Average of all connected cells ≥ 1.195

(a) It is acceptable for the electrolyte level to temporarily increase above the specified maximum level during equalizing charges provided it is not overflowing.

(b) Corrected for electrolyte temperature and level. Level correction is not required, however, when battery charging is < 2 amps when on float charge for vital batteries and < 1.0 amp for DG batteries.

(c) A battery charging current of < 2 amps when on float charge for vital batteries and < 1.0 amp for DG batteries is acceptable for meeting specific gravity limits following a battery recharge, for a maximum of 31 days. When charging current is used to satisfy specific gravity requirements, specific gravity of each connected cell shall be measured prior to expiration of the 31 day allowance.

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.4 DC Sources - Operating

BASES

BACKGROUND

The station DC electrical power system provides the AC emergency power system with control power. It also provides both motive and control power to selected safety related equipment and preferred AC vital bus power (via inverters). As required by 10 CFR 50, Appendix A, GDC 17 (Ref. 1), the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. The DC electrical power system also conforms to the recommendations of Regulatory Guide 1.6 (Ref. 2) and IEEE-308 (Ref. 3).

125 V Vital DC Electrical Power Subsystem

The vital 125 VDC electrical power system is a Class IE system whose safety function is to provide control power for engineered safety features equipment, emergency lighting, vital inverters, and other safety-related DC powered equipment for the entire unit. The system capacity is sufficient to supply these loads and any connected nonsafety loads during normal operation and to permit safe shutdown and isolation of the reactor for the "loss of all AC power" condition. The system is designed to perform its safety function subject to a single failure.

The 125V DC vital power system is composed of the four ~~redundant~~ channels (Channels I and III are associated with Train A and Channels II and IV are associated with Train B) and consists of four lead-acid-calcium batteries, eight battery chargers (including two pairs of spare chargers), four distribution boards, battery racks, and the required cabling, instrumentation and protective features. Each channel is electrically and physically independent from the equipment of all other channels so that a single failure in one channel will not cause a failure in another channel. Each channel consists of a battery charger which supplies normal DC power, a battery for emergency DC power, and a battery board which facilitates load grouping and provides circuit protection. These four channels are used to provide emergency power to the 120V AC vital power system which furnishes control power to the reactor protection system. No automatic connections are used between the four ~~redundant~~ channels.

Battery boards I, II, III, and IV have a charger normally connected to them and also have manual access to a spare (backup) charger for use upon loss of the normal charger.

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

Additionally, battery boards I, II, III, and IV have manual access to the fifth vital battery system. The fifth 125V DC Vital Battery System is intended to serve as a replacement for any one of the four 125V DC vital batteries during their testing, maintenance, and outages with no loss of system reliability under any mode of operation.

Each of the vital DC electrical power subsystems provide the control power for its associated Class 1E AC power load group, 6.9 kV switchgear, and 480 V load centers. The vital DC electrical power subsystems also provide DC electrical power to the inverters, which in turn power the AC vital buses. Additionally, they power the emergency DC lighting system.

The vital DC power distribution system is described in more detail in Bases for LCO 3.8.9, "Distribution System - Operating," and LCO 3.8.10, "Distribution Systems - Shutdown."

~~Each vital battery has adequate storage capacity to carry the required load continuously for at least 4 hours in the event of a loss of all AC power (station blackout) without an accident or for 30 minutes with an accident considering a single failure. Load shedding of nonrequired loads will be performed to achieve the required coping duration for station blackout conditions.~~

Each 125 VDC vital battery is separately housed in a ventilated room apart from its charger and distribution centers, except for Vital Battery V. Each subsystem is located in an area separated physically and electrically from the other subsystem to ensure that a single failure in one subsystem does not cause a failure in a redundant subsystem. There is no sharing between ~~redundant~~ Class 1E subsystems, such as batteries, battery chargers, or distribution panels.

Each battery has adequate storage capacity to meet the duty cycle(s) discussed in the FSAR, Chapter 8 (Ref 4). The battery is designed with additional capacity above that required by the design duty cycle to allow for temperature variations and other factors.

The batteries for the vital DC electrical power subsystems are sized to produce required capacity at 80% of nameplate rating, corresponding to warranted capacity at end of life cycles~~, derated for minimum ambient temperature~~ and the

(continued)

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

100% design demand. The minimum design voltage limit is 105 V.The voltage limit is 2.13 V per cell, which corresponds to a total minimum voltage output of 128 V per battery (132 V for Vital Battery V). The criteria for sizing large lead storage batteries are defined in IEEE-485 (Ref. 5).

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for a 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 132 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 4).

Each Vital DC electrical power subsystem battery charger has ample power output capacity for the steady state operation of connected loads required during normal operation, while at the same time maintaining its battery bank fully charged. Each battery charger also has sufficient excess capacity to restore the battery bank from the design minimum charge to its fully charged state within 12 hours (with accident loads being supplied) following a 30 minute AC power outage and in approximately 36 hours (while supplying normal steady state loads following a 2 hour AC power outage), (Ref. 65).

The battery charger is normally in the float-charge mode. Float-charge is the condition in which the charger is supplying the connected loads and the battery cells are receiving adequate current to optimally charge the battery. This assures the internal losses of a battery are overcome and the battery is maintained in a fully charged state.

When desired, the charger can be placed in the equalize mode. The equalize mode is at a higher voltage than the float mode and charging current is correspondingly higher. The battery charger is operated in the equalize mode after a battery discharge or for routine maintenance. Following a battery discharge, the battery recharge characteristic accepts current at the current limit of the battery charger (if the discharge was significant, e.g., following a battery service test) until the battery terminal voltage approaches the charger voltage setpoint. Charging current then reduces exponentially during the remainder of the recharge cycle. Lead-calcium batteries have recharge efficiencies of greater than 95%, so once at least 105% of the ampere-hours discharged have been returned, the battery capacity would be restored to the same condition as it was prior to the discharge. This can be monitored by direct observation of the exponentially decaying charging current or by evaluating the amp-hours discharged from the battery and amp-hours returned to the battery.

(continued)

BASES

BACKGROUND (continued)

125 V Diesel Generator (DG) DC Electrical Power Subsystem

Control power for the DGs is provided by five DG battery systems, one per DG. Each system is comprised of a battery, a dual battery charger assembly, distribution center, cabling, and cable ways. The DG 125V DC control power and field-flash circuits have power supplied from their respective 125V distribution panel. The normal supply of DC current is from the associated charger. The battery provides control and field-flash power when the charger is unavailable. The charger supplies the normal DC loads, maintains the battery in a fully charged condition, and recharges (480V AC available) the battery while supplying the required loads regardless of the status of the unit. The batteries are physically and electrically independent. The battery has sufficient capacity when fully charged to supply required loads for a minimum of 30 minutes following a loss of normal power. Each battery is normally required to supply loads during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from its respective DG.

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. ~~7~~6), and in the FSAR, Section 15 (Ref. ~~7~~6), assume that Engineered Safety Feature (ESF) systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining the DC sources OPERABLE during accident conditions in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

The DC sources satisfy Criterion 3 of the NRC Policy Statement.

(continued)

LCO

~~Four~~ Two 125V vital DC electrical power subsystems (Train A and Train B), each vital subsystem consisting of two channels. Each channel consisting of a battery bank, associated battery charger and the corresponding control equipment and interconnecting cabling supplying power to the associated DC bus within the channel; and ~~four~~ one DG DC electrical power ~~sub~~system~~s~~ for each DG, consisting of a battery, a dual battery charger assembly, and the corresponding control equipment and interconnecting cabling are required to be OPERABLE to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence (A00) or a postulated DBA. Loss of any DC electrical power subsystem does not prevent the minimum safety function from being performed (Ref. 4).

An OPERABLE vital DC electrical power subsystem requires all required batteries and respective chargers to be operating and connected to the associated DC buses.

Each DG DC electrical power system is independent and dedicated to its respective DG. The DGs that are supported by the DG DC electrical power systems are arranged in redundant trains (i.e., DG 1A-A and DG 2A-A are in Train A, and DG 1B-B and DG 2B-B are in Train B). When one or two DGs in a train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Likewise, if one or two of the DG DC electrical power systems that support the DGs in that train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Therefore, the LCO requires two DG DC electrical power trains to be OPERABLE to support the redundancy of the standby electrical power system.

The LCO is modified by ~~two~~ a Note~~s~~. The Note ~~1~~ indicates that Vital Battery V may be substituted for any of the required vital batteries. However, the fifth battery cannot be declared OPERABLE until it is connected electrically in place of another battery and it has satisfied applicable Surveillance Requirements. ~~Note 2 has been added to indicate that the C-S DG and its associated DC subsystem may be substituted for any of the required DGs. However, the C-S DG and its associated DC subsystem cannot be declared OPERABLE until it is connected electrically in place of another DG, and it has satisfied applicable Surveillance Requirements.~~

APPLICABILITY

The ~~four~~ vital DC electrical power sources and ~~four~~ DG DC electrical power sources are required to be OPERABLE in MODES 1, 2, 3, and 4 to ensure safe plant operation and to ensure that:

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOs or abnormal transients; and
b. Adequate core cooling is provided, and containment integrity and other vital functions are maintained in the event of a postulated DBA.

The DC electrical power requirements for MODES 5 and 6 are addressed in the Bases for LCO 3.8.5, "DC Sources - Shutdown."

(continued)

BASES

ACTIONS

A.1, A.2, and A.3

Condition A represents one vital DC subsystem with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action A.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage. Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action A.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action A.2).

Required Action A.2 requires that the battery float current be verified as less than or equal to 2 amps. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 2 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the

(continued)

ACTIONS

A.1, A.2, and A.3 (continued)

expiration of the initial 12 hour period the battery float current is not less than or equal to 2 amps this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action A.3 limits the restoration time for the inoperable battery charger to 7 days. This action is applicable if an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage has been used (e.g., balance of plant non-Class 1E battery charger). The 7 day Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

~~A~~B.1

Condition ~~A~~B represents one vital ~~channel~~ DC electrical power subsystem with a loss of ability to completely respond to an event, and a potential loss of ability to remain energized during normal operation. It is, therefore, imperative that the operator's attention focus on stabilizing the plant, minimizing the potential for complete loss of DC power to the affected ~~train~~ subsystem. The 2 hour limit is consistent with the allowed time for an inoperable DC distribution subsystem ~~train~~.

If one of the required vital DC electrical power subsystems is inoperable for reasons other than Condition A (e.g., ~~inoperable battery, inoperable battery charger(s), or~~ inoperable battery charger and associated inoperable battery), the remaining vital DC electrical power subsystem has the capacity to support a safe shutdown and to mitigate an accident condition. Since a subsequent worst case single failure of the OPERABLE subsystem ~~would~~ could, however, result in ~~a situation where the ability of the 125V DC electrical power subsystem to support its required ESF function is not assured,~~ the loss of the minimum necessary vital DC electrical power subsystems to mitigate a worst-case accident, continued power operation should not exceed 2 hours. The 2 hour Completion Time is based on Regulatory Guide 1.93 (Ref. ~~8~~7) and reflects a reasonable time to assess plant status as a function of the inoperable vital DC electrical power subsystem and, if the vital DC electrical power subsystem is not restored to OPERABLE status, to prepare to effect an orderly and safe plant shutdown.

~~B.1 and B.2~~C,1 and C.2

If the inoperable vital DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The Completion Time

(continued)

ACTIONS (continued)

~~B.1 and B.2~~C,1 and C.2 (continued)

to bring the plant to MODE 5 is consistent with the time required in Regulatory Guide 1.93 (Ref. ~~8~~7).

D.1, D.2, and D.3

Condition D represents one DG DC train with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action D.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage.

Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DG DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2).

(continued)

BASES

ACTIONS

D.1, D.2, and D.3 (continued)

Required Action D.2 requires that the battery float current be verified as less than or equal to 1 amp. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 1 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 1 amp this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action D.3 limits the restoration time for the inoperable battery charger to 72 hours. The 72 hour Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

~~C.1~~E.1

Condition ~~C~~E represents one DG with a loss of ability to completely respond to an event. Since a subsequent single failure on the opposite train could result in a situation where the required ESF function is not assured, continued power operation should not exceed 2 hours. The 2 hour time limit is consistent with the allowed time for an inoperable vital DC electrical power subsystem.

~~D.1~~F.1

If the DG DC electrical power subsystem cannot be restored to OPERABLE status in the associated Completion Time, the associated DG may be incapable of performing its intended function and must be immediately declared inoperable. This declaration also requires entry into applicable Conditions and Required Actions for an inoperable DG, LCO 3.8.1, "AC Sources-Operating."

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1 and SR 3.8.4.2

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the battery chargers, which support the ability of the batteries to perform their intended function charging system and the ability of the batteries to perform their intended function. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery (or battery cell) and maintain the battery (or a battery cell) in a fully charged state while supplying the continuous steady state loads of the associated DC subsystem. On float charge, battery cells will receive adequate current to optimally charge the battery. The voltage requirements are based on the critical nominal design voltage of the battery and are consistent with the initial voltages assumed in the battery sizing calculations minimum float voltage established by the battery manufacturer (2.20 Vpc times the number of connected cells or 132 V at the battery terminals for a 60 cell vital battery; 127.6 V at the battery terminals for a 58 cell DG battery). This voltage maintains the battery plates in a condition that supports maintaining the grid life. The 7 day Frequency is consistent with manufacturer recommendations and IEEE-450 (Ref. 9).

SR 3.8.4.3

Verifying that for the vital batteries that the alternate feeder breakers to each required battery charger is open ensures that independence between the power trains is maintained. The 7-day Frequency is based on engineering judgement, is consistent with procedural controls governing breaker operation, and ensures correct breaker position.

SR 3.8.4.4

This SR demonstrates that the DG 125V DC distribution panel and associated charger are functioning properly, with all required circuit breakers closed and buses energized from normal power. The 7 day Frequency takes into account the redundant DG capability and other indications available in the control room that will alert the operator to system malfunctions.

SR 3.8.4.5 and SR 3.8.4.6

Visual inspection to detect corrosion of the battery cells and connections, or measurement of the resistance of each intercell, interrack, intertier, and terminal connection, provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.5 and SR 3.8.4.6 (continued)

The limits established for this SR must be no more than 20% above the resistance as measured during installation, or not above the ceiling value established by the manufacturer.

The Surveillance Frequency for these inspections, which can detect conditions that can cause power losses due to resistance heating, is 92 days. This Frequency is considered acceptable based on operating experience related to detecting corrosion trends.

SR 3.8.4.7

Visual inspection of the battery cells, cell plates, and battery racks provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance.

The 12 month Frequency for this SR is consistent with IEEE-450 (Ref. 9), which recommends detailed visual inspection of cell condition and rack integrity on a yearly basis.

SR 3.8.4.8, SR 3.8.4.9 and SR 3.8.4.10

Visual inspection and resistance measurements of intercell, interrack, intertier, and terminal connections provide an indication of physical damage or abnormal deterioration that could indicate degraded battery condition. The anticorrosion material is used to help ensure good electrical connections and to reduce terminal deterioration. The visual inspection for corrosion is not intended to require removal of and inspection under each terminal connection. The removal of visible corrosion is a preventive maintenance SR. The presence of visible corrosion does not necessarily represent a failure of this SR provided visible corrosion is removed during performance of SR 3.8.4.8. For the purposes of trending, inter-cell (vital and DG batteries) and inter-tier (vital and DG batteries) connections are measured from battery post to battery post. Inter-rack (vital batteries), inter-tier (DG Batteries), and terminal connections (vital and DG batteries) are measured from terminal lug to battery post.

(continued)

SURVEILLANCE REQUIREMENTS

~~SR 3.8.4.8, SR 3.8.4.9 and SR 3.8.4.10 (continued)~~

~~The connection resistance limits for SR 3.8.4.9 and SR 3.8.4.10 shall be no more than 20% above the resistance as measured during installation, or not above the ceiling value established by the manufacturer.~~

~~The Surveillance Frequencies of 12 months is consistent with IEEE-450 (Ref. 9), which recommends cell to cell and terminal connection resistance measurement on a yearly basis.~~

SR 3.8.4.~~11~~5

This SR ~~requires that each vital battery charger be capable of recharging its associated battery from a capacity or service discharge test while supplying normal loads, or alternatively, operating at current limit for a minimum of 4 hours at a nominal 125 VDC. These requirements are based on~~ verifies the design capacity of the vital battery chargers ~~(Ref. 4) and their performance characteristic of current limit operation for a substantial portion of the recharge period. Battery charger output current is limited to 110% - 125% of the 200 amp rated output. Recharging the battery or testing for a minimum of 4 hours is sufficient to verify the output capability of the charger can be sustained, that current limit adjustments are properly set and that protective devices will not inhibit performance at current limit settings~~. According to Regulatory Guide 1.32 (Ref. ~~6~~5), the battery charger supply is ~~required~~ recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. ~~Verifying the capability of the charger to operate in a sustained current limit condition~~ The minimum required amperes and duration ensure~~s~~ that these requirements can be satisfied.

This SR provides two options. One option requires that each battery charger be capable of supplying 200 amps at the minimum established float voltage (132 V DC) for 4 hours. The ampere requirements are based on the output rating of the chargers. The voltage requirements are based on the charger voltage level after a response to a loss of AC power.

The other option requires that each vital battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 2 amps.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.~~11~~5 (continued)

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

~~This SR is modified by a Note. The reason for the Note is that performing the Surveillance may perturb the electrical distribution system and challenge safety systems. This Surveillance is normally performed during MODES 5 and 6 since it would require the DC electrical power subsystem to be inoperable during performance of the test. However, this Surveillance may be performed in MODES 1, 2, 3, or 4 provided the Vital Battery V is substituted in accordance with LCO Note 1. Credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:~~

~~1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and~~

~~2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.~~

SR 3.8.4.~~12~~6

This SR ~~requires that each diesel generator battery charger be capable of recharging its associated battery from a capacity or service discharge test while supplying normal loads, or alternatively, operating at current limit for a minimum of 4 1/2 hours at a nominal 125 VDC. This requirement is based on~~ verifies the design capacity of the DG battery chargers ~~(Ref. 13) and their performance characteristic of current limit operation for a substantial portion of the recharge period. Battery charger output current is limited to a maximum of 140% of the 20 amp rated output. Recharging the battery verifies the output capability of the charger can be sustained, that current limit adjustments are properly set and that protective devices will not inhibit performance at current limit settings~~. According to Regulatory Guide 1.32 (Ref. ~~6~~5), the battery charger supply is ~~required~~ recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. ~~Verifying the capability of the charger to operate in a sustained current limit condition~~ The minimum required amperes and duration ensure~~s~~ that these requirements can be satisfied.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.126 (continued)

This SR requires that each DG battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 1 amp.

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

For the DG DC electrical subsystem, this Surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the DG DC electrical power subsystem supplies loads only for the inoperable diesel generator and would not otherwise challenge safety systems supplied from vital electrical distribution systems. If available, the C-S DG and its associated DC electrical power subsystem may be substituted in accordance with LCO Note 2. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

SR 3.8.4.137

A battery service test is a special test of battery capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The discharge rate and test length should correspond to worst case design duty cycle requirements based on References 108 and 1210.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.~~13~~7 (continued)

The Surveillance Frequency of 18 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. ~~6~~5) and Regulatory Guide 1.129 (Ref. ~~11~~9), which state that the battery service test should be performed during refueling operations or at some other outage, with intervals between tests, not to exceed 18 months.

This SR is modified by two Notes. Note 1 allows the performance of a modified performance discharge test in lieu of a service test ~~once per 60 months~~. ~~The modified performance discharge test is a simulated duty cycle consisting of just two rates; the one minute rate published for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a rated one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test should remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.~~

~~A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle.) This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.~~

The reason for Note 2 is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES l, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note l. For the DG DC electrical subsystem, this surveillance may be performed in MODES l, 2, 3, or 4 in conjunction with LCO 3.8.l.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. If available, the C-S DG and its associated DC electrical power subsystem may be substituted in accordance with LCO Note 2. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.137 (continued)

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

~~SR 3.8.4.14~~

~~A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.~~

~~A battery modified performance discharge test is described in the Bases for 3.8.4.13. Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.4.14; however, only the modified performance discharge test may be used to satisfy SR 3.8.4.14 while satisfying the requirements of SR 3.8.4.13 at the same time.~~

~~The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 9) and IEEE-485 (Ref. 5). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements.~~

~~The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's rating. Degradation is indicated, according to IEEE-450 (Ref. 9), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 9).~~

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.14 (continued)

This SR is modified by a Note. The reason for the Note is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES I, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note I. For the DG DC electrical subsystem, this surveillance may be performed in MODES I, 2, 3, or 4 in conjunction with LCO 3.8.I.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. If available, the C-S DG and its associated DC electrical power subsystem may be substituted in accordance with LCO Note 2. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

(continued)

BASES (continued)

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, Appendix A, General Design Criterion 17, “Electric Power System.”

2. Regulatory Guide 1.6, “Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems,” U.S. Nuclear Regulatory Commission, March 10, 1971.

3. IEEE-308-1971, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” Institute of Electrical and Electronic Engineers.

4. Watts Bar FSAR, Section 8.3.2, “DC Power System.”

~~5. IEEE-485-1983, “Recommended Practices for Sizing Large Lead Storage Batteries for Generating Stations and Substations,” Institute of Electrical and Electronic Engineers.~~

~~6~~5. Regulatory Guide 1.32, “Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants,” February 1977, U.S. Nuclear Regulatory Commission.

~~7~~6. Watts Bar FSAR, Section 15, “Accident Analysis” and Section 6 “Engineered Safety Features.”

~~8~~7. Regulatory Guide 1.93, “Availability of Electric Power Sources,” U.S. Nuclear Regulatory Commission, December 1974.

~~9. IEEE-450-1980/1995, “IEEE Recommended Practice for Maintenance Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Subsystems,” Institute of Electrical and Electronic Engineers.~~

~~10~~8. TVA Calculation WBN EEB-MS-TI11-0003, “125 VDC Vital Battery and Charger Evaluation.”

~~11~~9. Regulatory Guide 1.129, “Maintenance Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Subsystems,” U.S. Nuclear Regulatory Commission, February 1978.

(continued)

BASES

REFERENCES (continued)

~~12~~10. TVA Calculation WBN EEB-MS-TI11-0062, "125 V DC Diesel Generator Control Power System Evaluation."

~~13. Watts Bar FSAR, Section 8.3.1, "AC Power System."~~

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.6 Battery ~~Cell~~ Parameters

BASES

BACKGROUND

This LCO delineates the limits on battery float current as well as electrolyte temperature, level, and float voltage~~, and specific gravity~~ for the 125V vital DC electrical power subsystem and diesel generator (DG) batteries. A discussion of these batteries and their OPERABILITY requirements is provided in the Bases for LCO 3.8.4, "DC Sources - Operating," and LCO 3.8.5, "DC Sources - Shutdown." In addition to the limitations of this Specification, the Battery Monitoring and Maintenance Program also implements a program specified in Specification 5.7.2.22 for monitoring various battery parameters.

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 3).

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 1) and Section 15 (Ref. 1), assume Engineered Safety Feature systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining at least one ~~train~~ subsystem of DC sources OPERABLE during accident conditions, in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

Battery ~~cell~~ parameters satisfy the Criterion 3 of the NRC Policy Statement.

BASES (continued)

LCO

Battery cell parameters must remain within acceptable limits to ensure availability of the required DC power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. Electrolyte Battery parameter limits are conservatively established, allowing continued DC electrical system function even with Category A and B limits not met. Additional preventative maintenance, testing, and monitoring performed in accordance with the Battery Monitoring and Maintenance Program is conducted as specified in Specification 5.7.2.22.

APPLICABILITY

The battery cell parameters are required solely for the support of the associated vital DC and DG DC electrical power subsystems. Therefore, battery electrolyte is parameter limits are only required when the DC power source is required to be OPERABLE. Refer to the Applicability discussion in Bases for LCO 3.8.4 and LCO 3.8.5.

ACTIONS

A.1, A.2, and A.3

With one or more cells in one or more batteries not within limits (i.e., Category A limits not met, Category B limits not met, or Category A and B limits not met) but within the Category C limits specified in Table 3.8.6-1 in the accompanying LCO, the battery is degraded but there is still sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of Category A or B limits not met, and operation is permitted for a limited period.

The pilot cell electrolyte level and float voltage are required to be verified to meet the Category C limits within 1 hour (Required Action A.1). This check will provide a quick indication of the status of the remainder of the battery cells. One hour provides time to inspect the electrolyte level and to confirm the float voltage of the pilot cells. One hour is considered a reasonable amount of time to perform the required verification.

Verification that the Category C limits are met (Required Action A.2) provides assurance that during the time needed to restore the parameters to the Category A and B limits, the battery is still capable of performing its intended function. A period of 24 hours is allowed to complete the initial verification because specific gravity measurements must be obtained for each connected cell. Taking into consideration both the time required to perform the required verification and the assurance that the battery cell

(continued)

BASES

ACTIONS

A.1, A.2, and A.3 (continued)

parameters are not severely degraded, this time is considered reasonable. The verification is repeated at 7 day intervals until the parameters are restored to Category A and B limits. This periodic verification is consistent with the normal Frequency of pilot cell surveillances.

Continued operation is only permitted for 31 days before battery cell parameters must be restored to within Category A and B limits. With the consideration that, while battery capacity is degraded, sufficient capacity exists to perform the intended function and to allow time to fully restore the battery cell parameters to normal limits, this time is acceptable prior to declaring the battery inoperable.

A.1, A.2, and A.3

With one or more cells in one or more batteries in one vital DC subsystem < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.1) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.1). This assures that there is still sufficient battery capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.1 or SR 3.8.6.1 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.1 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

B.1 and B.2

One or more batteries in one vital DC subsystem with float current > 2 amps indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition A addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the

(continued)

BASES

ACTIONS

B.1 and B.2 (continued)

battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action B.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.4.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

C.1, C.2, and C.3

With one or more cells in one or more batteries in one DG DC train < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.2) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.2). This assures that there is still sufficient battery capacity to perform the intended function.

Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

(continued)

BASES

ACTIONS

C.1, C.2, and C.3 (continued)

Since the Required Actions only specify "perform," a failure of SR 3.8.4.2 or SR 3.8.6.2 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.2 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

D.1 and D.2

One or more batteries in one DG DC train with float current > 1 amp indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition B addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not

(continued)

ACTIONS

D.1 and D.2 (continued)

indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action D.1 only specifies "perform," a failure of SR 3.8.4.2 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.2 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

E.1, E.2, and E.3

With one or more required batteries in one vital DC subsystem or one or more DG batteries in one train with one or more cells electrolyte level above the top of the plates, but below the minimum established design limits, the battery still retains sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of electrolyte level not met. Within 31 days the minimum established design limits for electrolyte level must be re-established.

With electrolyte level below the top of the plates there is a potential for dryout and plate degradation. Required Actions E.1 and E.2 address this potential (as well as provisions in Specification 5.7.2.22, Battery Monitoring and Maintenance Program). They are modified by a Note that indicates they are only applicable if electrolyte level is below the top of the plates. Within 8 hours level is required to be restored to above the top of the plates. The Required Action E.2 requirement to verify that there is no leakage by visual inspection and the Specification 5.7.2.22.b item to initiate action to equalize and test in accordance with manufacturer's recommendation. They are performed following the restoration of the electrolyte level to above the top of the plates. Based on the results of the manufacturer's recommended testing the battery(ies) may have to be declared inoperable and the affected cell(s) replaced.

F.1

With one or more batteries in one vital DC subsystem or one or more DG batteries in one train with pilot cell temperature less than the minimum established design limits, 12 hours is allowed to restore the temperature to within limits. A low electrolyte temperature limits the current and power available. Since the battery is sized with margin, while battery capacity is degraded, sufficient capacity exists to perform the intended function and the affected battery is not required to be considered inoperable solely as a result of the pilot cell temperature not met.

(continued)

BASES

ACTIONS (continued)

G.1

With one or more vital batteries in redundant DC subsystems with battery parameters not within limits there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function, given that redundant batteries are involved. With redundant batteries involved this potential could result in a total loss of function on multiple systems that rely upon the batteries.

The longer Completion Times specified for vital battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one subsystem within 2 hours.

H.1

With one or more DG batteries in redundant DG trains with battery parameters not within limits, there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function. With batteries in redundant DG trains involved, this potential could result in a total loss of function for DGs that rely upon the batteries.

The longer Completion Times specified for battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one train within 2 hours.

~~B~~I.1

With one or more batteries with ~~one or more~~ any battery ~~cell~~ parameter~~s~~ outside the ~~Category C limits for any connected cell,~~ allowances of the Required Actions for Condition A, B, C, D, E, F, G, or H, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding ~~vital DC or DG DC electrical power subsystem~~ battery must be declared inoperable. Additionally, ~~other potentially extreme conditions, such as not completing the Required Actions of Condition A within the required Completion Time or average electrolyte temperature of representative cells falling below 60°F for the vital batteries or 50°F for DG batteries, are also cause for immediately declaring the associated vital DC or DG DC electrical power subsystem inoperable.~~ discovering one or more vital DC batteries in one subsystem with one or more battery cells float voltage less than 2.07 V and float current greater than 2 amps, or one or more DG batteries in one train with one or more battery cells float voltage greater than or equal to 2.07 V and float current greater than 1 amp, indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1

This SR verifies that Category A battery cell parameters are consistent with IEEE-450 (Ref. 2), which recommends regular battery inspections (at least one per month) including voltage, specific gravity, and electrolyte temperature of pilot cells.

SR 3.8.6.2

The quarterly inspection of specific gravity and voltage is consistent with IEEE-450 (Ref. 2). In addition, within 24 hours of a battery discharge < 110 V (113.5V for Vital Battery V or 106.5 for DG batteries) or a battery overcharge > 150 V (155 V for Vital Battery V or 145 V for DG batteries), the battery must be demonstrated to meet Category B limits. Transients, such as motor starting transients, which may momentarily cause battery voltage to drop to ≤ 110 V (113.5 V for Vital Battery V or 106.5 V for DG batteries), do not constitute a battery discharge provided the battery terminal voltage and float current return to pre-transient values. This inspection is also consistent with IEEE-450 (Ref. 2), which recommends special inspections following a severe discharge or overcharge, to ensure that no significant degradation of the battery occurs as a consequence of such discharge or overcharge.

SR 3.8.6.3

This Surveillance verification that the average temperature of representative cells is ≥ 60°F for the vital batteries and ≥ 50°F for the DG batteries, is consistent with a recommendation of IEEE-450 (Ref. 2), that states that the temperature of electrolytes in representative cells should be determined on a quarterly basis.

Lower than normal temperatures act to inhibit or reduce battery capacity. This SR ensures that the operating temperatures remain within an acceptable operating range. This limit is based on manufacturer recommendations.

Table 3.8.6-1

This table delineates the limits on electrolyte level, float voltage, and specific gravity for three different categories. The meaning of each category is discussed below.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

Table 3.8.6-1 (continued)

Category A defines the normal parameter limit for each designated pilot cell in each battery. The cells selected as pilot cells are those whose temperature, voltage, and electrolyte specific gravity approximate the state of charge of the entire battery.

The Category A limits specified for electrolyte level are based on manufacturer recommendations and are consistent with the guidance in IEEE-450 (Ref. 2), with the extra ¼ inch allowance above the high water level indication for operating margin to account for temperatures and charge effects. In addition to this allowance, footnote a to Table 3.8.6-1 permits the electrolyte level to be above the specified maximum level during equalizing charge, provided it is not overflowing. These limits ensure that the plates suffer no physical damage, and that adequate electron transfer capability is maintained in the event of transient conditions. IEEE-450 (Ref. 2) recommends that electrolyte level readings should be made only after the battery has been at float charge for at least 72 hours.

The Category A limit specified for float voltage is ≥ 2.13 V per cell. This value is based on the recommendations of IEEE-450 (Ref. 2), which states that prolonged operation of cells < 2.13 V can reduce the life expectancy of cells.

The Category A limit specified for specific gravity for each pilot cell is ≥ 1.200 (0.015 below the manufacturer fully charged nominal specific gravity or a battery charging current that had stabilized at a low value). This value is characteristic of a charged cell with adequate capacity. According to IEEE-450 (Ref. 2), the specific gravity readings are based on a temperature of 77°F (25°C).

The specific gravity readings are corrected for actual electrolyte temperature and level. For each 3°F (1.67°C) above 77°F (25°C), 1 point (0.001) is added to the reading; 1 point is subtracted for each 3°F below 77°F. The specific gravity of the electrolyte in a cell increases with a loss of water due to electrolysis or evaporation.

(continued)

BASES

~~SURVEILLANCE REQUIREMENTS~~

~~Table 3.8.6-1 (continued)~~

~~Category B defines the normal parameter limits for each connected cell. The term "connected cell" excludes any battery cell that may be jumpered out.~~

~~The Category B limits specified for electrolyte level and float voltage are the same as those specified for Category A and have been discussed above. The Category B limit specified for specific gravity for each connected cell is ≥ 1.195 (0.020 below the manufacturer fully charged, nominal specific gravity) with the average of all connected cells > 1.205 (0.010 below the manufacturer fully charged, nominal specific gravity). These values are based on manufacturer's recommendations. The minimum specific gravity value required for each cell ensures that the effects of a highly charged or newly installed cell will not mask overall degradation of the battery.~~

~~Category C defines the limits for each connected cell. These values, although reduced, provide assurance that sufficient capacity exists to perform the intended function and maintain a margin of safety. When any battery parameter is outside the Category C limits, the assurance of sufficient capacity described above no longer exists, and the battery must be declared inoperable.~~

~~The Category C limits specified for electrolyte level (above the top of the plates and not overflowing) ensure that the plates suffer no physical damage and maintain adequate electron transfer capability. The Category C limits for float voltage is based on IEEE-450 (Ref. 2), which states that a cell voltage of 2.07 V or below, under float conditions and not caused by elevated temperature of the cell, indicates internal cell problems and may require cell replacement.~~

~~The Category C limits of average specific gravity ≥ 1.195 is based on manufacturer recommendations (0.020 below the manufacturer recommended~~

(continued)

BASES

SURVEILLANCE REQUIREMENTS

Table 3.8.6-1 (continued)

fully charged, nominal specific gravity). In addition to that limit, it is required that the specific gravity for each connected cell must be no less than 0.020 below the average of all connected cells. This limit ensures that the effect of a highly charged or new cell does not mask overall degradation of the battery.

The footnotes to Table 3.8.6-1 are applicable to Category A, B, and C specific gravity. Footnote b to Table 3.8.6-1 requires the above mentioned correction for electrolyte level and temperature, with the exception that level correction is not required when battery charging current is < 2 amps on float charge for vital batteries and < 1.0 amps for DG batteries. This current provides, in general, an indication of overall battery condition.

Because of specific gravity gradients that are produced during the recharging process, delays of several days may occur while waiting for the specific gravity to stabilize. A stabilized charger current is an acceptable alternative to specific gravity measurement for determining the state of charge. This phenomenon is discussed in IEEE-450 (Ref. 2). Footnote c to Table 3.8.6-1 allows the float charge current to be used as an alternate to specific gravity for up to 31 days following a battery recharge. Within 31 days each connected cell's specific gravity must be measured to confirm the state of charge. Following a minor battery recharge (such as equalizing charge that does not follow a deep discharge) specific gravity gradients are not significant, and confirming measurements may be made in less than 31 days.

SR 3.8.6.1 and SR 3.8.6.2

Verifying battery float current while on float charge is used to determine the state of charge of the battery. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The equipment used to monitor float current must have the necessary accuracy and capability to measure electrical currents in the expected range. The float current requirements are based on the float current indicative of a charged battery. The 7 day Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.1 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION A are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 2 amps is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.2 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. When this float voltage is not maintained

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1 and SR 3.8.6.2 (continued)

the Required Actions of LCO 3.8.4 ACTION D are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 1 amp is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.3 and SR 3.8.6.6

Optimal long term battery performance is obtained by maintaining a float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer, which corresponds to 132 V at the battery terminals, or 2.20 Vpc. This provides adequate overpotential, which limits the formation of lead sulfate and self discharge, which could eventually render the battery inoperable. Float voltages in this range or less, but greater than 2.07 Vpc, are addressed in Specification 5.7.2.22. SRs 3.8.6.3 and 3.8.6.6 require verification that the cell float voltages are equal to or greater than the short term absolute minimum voltage of 2.07 V. The Frequency for cell voltage verification every 31 days for pilot cell and 92 days for each connected cell is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.4

The limit specified for electrolyte level ensures that the plates suffer no physical damage and maintains adequate electron transfer capability. The minimum design electrolyte level is the minimum level indication mark on the battery cell jar. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.5

This Surveillance verifies that the pilot cell temperature is greater than or equal to the minimum established design limit (i.e., 60°F for the vital batteries and 50°F for the DG batteries). Pilot cell electrolyte temperature is maintained above this temperature to assure the battery can provide the required current and voltage to meet the design requirements. Temperatures lower than assumed in battery sizing calculations act to inhibit or reduce battery capacity. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.7

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.6.7; however, only the modified

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.6.7 (continued)

performance discharge test may be used to satisfy the battery service test requirements of SR 3.8.4.7.

A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle). This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

It may consist of just two rates; for instance the one minute rate for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test must remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 2) and IEEE-485 (Ref. 4). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer's rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements. Furthermore, the battery is sized to meet the assumed duty cycle loads when the battery design capacity reaches this 80% limit.

The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's ratings. Degradation is indicated, according to IEEE-450 (Ref. 2), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer's rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 2).

This SR is modified by a Note. The reason for the Note is that performing the Surveillance would perturb the electrical distribution system and challenge safety systems. Credit may be taken for unplanned events that satisfy this SR.

(continued)

BASES

REFERENCES

1. Watts Bar FSAR, Section 15, "Accident Analysis," and Section 6, "Engineered Safety Features."

2. IEEE-450~~-1980/1995~~2002, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of ~~Large~~ Vented Lead-Acid ~~Storage~~ Batteries for ~~Generating Stations and Substations~~Stationary Applications."

3. Watts Bar FSAR, Section 8, "Electric Power."

4. IEEE-485-1983, "IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations."

WBN Unit 2 Markups of Technical Specification and Bases

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources - Operating

LCO 3.8.4 Four channels of The Train A and Train B vital DC and four Diesel Generator (DG) DC electrical power subsystems shall be OPERABLE.

---NOTE---
Vital Battery V may be substituted for any of the required vital batteries.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery charger(s) on one subsystem inoperable.	A.1 Restore battery terminal voltage to greater than or equal to the minimum established float voltage. AND A.2 Verify battery float current ≤ 2 amps. AND A.3 Restore vital battery charger(s) to OPERABLE status.	2 hours Once per 12 hours 7 days
AB. One vital DC electrical power subsystem inoperable for reasons other than Condition A.	AB.1 Restore vital DC electrical power subsystem to OPERABLE status.	2 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
~~B~~C. Required Action and Associated Completion Time of Condition A or B not met.	~~B~~C.1 Be in MODE 3. AND ~~B~~C.2 Be in MODE 5.	6 hours 36 hours
D. One or two DG DC battery charger(s) on one train inoperable.	D.1 Restore DG battery terminal voltage to greater than or equal to the minimum established float voltage. AND D.2 Verify battery float current ≤ 1 amp. AND D.3 Restore DG battery charger(s) to OPERABLE status.	2 hours Once per 12 hours 72 hours
~~C~~E. One DG DC ~~electrical power subsystem~~ train inoperable for reasons other than Condition D.	~~C~~E.1 Restore DG DC ~~electrical power subsystem~~ train to OPERABLE status.	2 hours
~~D~~F. Required Action and associated Completion Time of Condition ~~C~~D or E not met.	~~D~~F.1 Declare associated DG inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify vital battery terminal voltage is ~~≥ 128 V (132 V for vital battery V) on float charge~~ greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.2	Verify DG battery terminal voltage is ~~≥ 124 V on float charge~~ greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.3	Verify for the vital batteries that the alternate feeder breakers to each required battery charger are open.	7 days
SR 3.8.4.4	Verify correct breaker alignment and indicated power availability for each DG 125 V DC distribution panel and associated battery charger	7 days
~~SR 3.8.4.5~~	~~Verify no visible corrosion at terminals and connectors for the vital batteries.~~ ~~OR~~ ~~Verify connection resistance for the vital batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 ohm for inter-rack connections, ≤ 120 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~92 days~~
~~SR 3.8.4.6~~	~~Verify no visible corrosion at terminals and connectors for the DG batteries.~~ ~~OR~~ ~~Verify connection resistance for the DG batteries is ≤ 80 E-6 ohm for inter-cell connections, ≤ 50 E-6 ohm for inter-tier connections, and ≤ 50 E-6 ohm for terminal connections.~~	~~92 days~~
~~SR 3.8.4.7~~	~~Verify battery cells, cell plates, and racks show no visual indication of physical damage or abnormal deterioration.~~	~~12 months~~

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
~~SR 3.8.4.8~~	~~Remove visible terminal corrosion and verify battery cell to cell and terminal connections are coated with anti-corrosion material.~~	~~12 months~~
~~SR 3.8.4.9~~	~~Verify connection resistance for the vital batteries is~~ ~~≤ 80 E-6 ohm for inter-cell connections,~~ ~~≤ 50 E-6 ohm for inter-rack connections,~~ ~~≤ 120 E-6 ohm for inter-tier connections, and~~ ~~≤ 50 E-6 ohm for terminal connections.~~	~~12 months~~
~~SR 3.8.4.10~~	~~Verify connection resistance for the DG batteries is~~ ~~≤ 80 E-6 ohm for inter-cell connections,~~ ~~≤ 50 E-6 ohm for inter-tier connections, and~~ ~~≤ 50 E-6 ohm for terminal connections.~~	~~12 months~~
SR 3.8.4.~~11~~5	~~-----NOTE-----~~ ~~This Surveillance is normally not performed in MODE 1, 2, 3, or 4. However, credit may be taken for unplanned events that satisfy this SR.~~ ~~----------~~ Verify each vital battery charger ~~is capable of recharging its associated battery from a service or capacity discharge test while supplying normal loads~~ supplies ≥ 200 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours. OR Verify each vital battery charger can recharge the battery to the fully charged state within 36 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state ~~is capable of operating for ≥ 4 hours at current limit 220 – 250 amps~~.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.~~12~~6	-------------------------------NOTE----------------------------- Credit may be taken for unplanned events that satisfy this SR. --- Verify each ~~diesel generator~~ DG battery charger ~~is capable of recharging its associated battery from a service or capacity discharge test while supplying normal loads~~ can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months
SR 3.8.4.~~13~~7	-------------------------------NOTES--------------------------- 1. The modified performance discharge test in SR 3.8.~~4.14~~6.7 may be performed in lieu of the service test in SR 3.8.4.~~13~~7 ~~once per 60 months~~. 2. This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --- Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads and any connected nonsafety loads for the design duty cycle when subjected to a battery service test.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
~~SR 3.8.4.14~~	~~-----------------------------NOTE-----------------------------~~ ~~This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR.~~ ~~---~~ ~~Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.~~	~~60 months~~ ~~AND~~ ~~12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating~~ ~~AND~~ ~~24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating~~

3.8 ELECTRICAL POWER SYSTEMS

3.8.6 Battery ~~Cell~~ Parameters

LCO 3.8.6 Battery ~~cell~~ parameters for <u>Train A and Train B electrical power subsystem</u> 125 V vital batteries and 125 V diesel generator (DG) batteries shall be within ~~the~~ limits ~~of Table 3.8.6-1~~.

APPLICABILITY: When associated DC electrical power subsystems and DGs are required to be OPERABLE.

ACTIONS

---NOTE---
Separate Condition entry is allowed for each battery bank.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
~~A. One or more batteries with one or more battery cell parameters not within Category A or B limits.~~	~~A.1 Verify pilot cells electrolyte level and float voltage meet Table 3.8.6-1 Category C limits.~~	~~1 hour~~
	~~AND~~	
	~~A.2 Verify battery cell parameters meet Table 3.8.6-1 Category C limits.~~	~~24 hours~~ ~~AND~~ ~~Once per 7 days thereafter~~
	~~AND~~	
	~~A.3 Restore battery cell parameters to category A and B limits of Table 3.8.6-1.~~	~~31 days~~

~~(continued)~~

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V.	A.1 Perform SR 3.8.4.1.	2 hours
	AND	
	A.2 Perform SR 3.8.6.1.	2 hours
	AND	
	A.3 Restore affected cell voltage ≥ 2.07 V.	24 hours
B. One or two required vital battery(ies) on one subsystem with float current > 2 amps.	B.1 Perform SR 3.8.4.1.	2 hours
	AND	
	B.2 Restore vital battery float current to ≤ 2 amps.	12 hours
C. One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V.	C.1 Perform SR 3.8.4.2.	2 hours
	AND	
	C.2 Perform SR 3.8.6.2.	2 hours
	AND	
	C.3 Restore affected cell voltage ≥ 2.07 V.	24 hours
D. One or two DG battery(ies) on one train with float current > 1 amp.	D.1 Perform SR 3.8.4.2.	2 hours
	AND	
	D.2 Restore DG battery float current to ≤ 1 amp.	12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
------------NOTE------------ Required Action E.2 shall be completed if electrolyte level was below the top of plates. --------------------------------- E. One or two required vital battery(ies) on one subsystem with one or more cells electrolyte level less than minimum established design limits. OR One or two DG battery(ies) on one train with one or more cells electrolyte level less than minimum established design limits.	------------NOTE------------ Required Actions E.1 and E.2 are only applicable if electrolyte level was below the top of plates. --------------------------------- E.1 Restore electrolyte level to above top of plates. AND E.2 Verify no evidence of leakage. AND E.3 Restore electrolyte level to greater than or equal to minimum established design limits.	 8 hours 12 hours 31 days
F. One or two required vital battery(ies) on one subsystem with pilot cell electrolyte temperature less than minimum established design limits. OR One or two DG battery(ies) on one train with pilot cell electrolyte temperature less than minimum established design limits.	F.1 Restore battery pilot cell temperature to greater than or equal to minimum established design limits.	12 hours

(continued)

(ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
G. One or more vital batteries in redundant subsystems with battery parameters not within limits.	G.1 Restore battery parameters for vital batteries in one subsystem to within limits.	2 hours
H. One or more DG batteries in redundant trains with battery parameters not within limits.	H.1 Restore battery parameters for DG batteries in one train to within limits.	2 hours

(ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
~~B~~I. Required Action and associated Completion Time of Condition A, B, C, D, E, F, G, or H not met. OR One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V and float current > 2 amps. OR One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V and float current > 1 amp. ~~One or more batteries with average electrolyte temperature of the representative cells < 60°F for vital batteries and < 50°F for DG batteries.~~ ~~OR~~ ~~One or more batteries with one or more battery cell parameters not within Category C values.~~	~~B~~I.1 Declare associated battery inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	Verify battery cell parameters meet Table 3.8.6-1 Category A limits.	7 days
SR 3.8.6.2	Verify battery cell parameters meet Table 3.8.6-1 Category B limits.	92 days AND Once within 24 hours after a battery discharge < 110 V for vital batteries (113.5 V for vital battery V) or 106.5 V for DG batteries AND Once within 24 hours after a battery overcharge > 150 V for vital batteries (155 V for vital battery V) or 145 V for DG batteries
SR 3.8.6.3	Verify average electrolyte temperature of representative cells is ≥ 60°F for vital batteries and ≥ 50°F for the DG batteries.	92 days

Insert Surveillance Requirements from next page.

Insert the following Surveillance Requirements for LCO 3.8.6:

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	----------------------------NOTE------------------------------- Not required to be met when vital battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. -- Verify each vital battery float current is ≤ 2 amps.	7 days
SR 3.8.6.2	----------------------------NOTE------------------------------- Not required to be met when DG battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. -- Verify each DG battery float current is ≤ 1 amp.	7 days
SR 3.8.6.3	Verify each required vital battery and each DG battery pilot cell float voltage is ≥ 2.07 V.	31 days
SR 3.8.6.4	Verify each required vital battery and each DG battery connected cell electrolyte level is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.5	Verify each required vital battery and each DG battery pilot cell temperature is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.6	Verify each required vital battery and each DG battery connected cell float voltage is ≥ 2.07 V.	92 days

SURVEILLANCE		FREQUENCY
SR 3.8.6.7	----------------------------NOTES-------------------------- This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --- Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.	60 months AND 12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating AND 24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating

Table 3.8.6-1 (page 1 of 1)
Battery Cell Parameters Requirements

PARAMETER	CATEGORY A: LIMITS FOR EACH DESIGNATED PILOT CELL	CATEGORY B: LIMITS FOR EACH CONNECTED CELL	CATEGORY C: ALLOWABLE LIMIT FOR EACH CONNECTED CELL
Electrolyte Level	> Minimum level indication mark, and ≤ 1/4 inch above maximum level indication mark [(a)]	> Minimum level indication mark, and ≤ 1/4 inch above maximum level indication mark [(a)]	Above top of plates, and not overflowing
Float Voltage	≥ 2.13 V	≥ 2.13 V	> 2.07 V
Specific Gravity [(b)(c)]	≥ 1.200	≥ 1.195 AND Average of all connected cells > 1.205	Not more than 0.020 below average of all connected cells AND Average of all connected cells ≥ 1.195

(a) It is acceptable for the electrolyte level to temporarily increase above the specified maximum level during equalizing charges provided it is not overflowing.

(b) Corrected for electrolyte temperature and level. Level correction is not required, however, when battery charging is < 2 amps when on float charge for vital batteries and < 1.0 amp for DG batteries.

(c) A battery charging current of < 2 amps when on float charge for vital batteries and < 1.0 amp for DG batteries is acceptable for meeting specific gravity limits following a battery recharge, for a maximum of 31 days. When charging current is used to satisfy specific gravity requirements, specific gravity of each connected cell shall be measured prior to expiration of the 31 day allowance.

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.4 DC Sources - Operating

BASES

BACKGROUND

The station DC electrical power system provides the AC emergency power system with control power. It also provides both motive and control power to selected safety related equipment and preferred AC vital bus power (via inverters). As required by 10 CFR 50, Appendix A, GDC 17 (Ref. 1), the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. The DC electrical power system also conforms to the recommendations of Regulatory Guide 1.6 (Ref. 2) and IEEE-308 (Ref. 3).

<u>125 V Vital DC Electrical Power Subsystem</u>

The vital 125 VDC electrical power system is a Class 1E system whose safety function is to provide control power for engineered safety features equipment, emergency lighting, vital inverters, and other safety related DC powered equipment for the entire unit. The system capacity is sufficient to supply these loads and any connected non-safety loads during normal operation and to permit safe shutdown and isolation of the reactor for the “loss of all AC power” condition. The system is designed to perform its safety function subject to a single failure.

The 125V DC vital power system is composed of the four ~~redundant~~ channels (Channels I and III are associated with Train A and Channels II and IV are associated with Train B) and consists of four lead-acid-calcium batteries, eight battery chargers (including two pairs of spare chargers), four distribution boards, battery racks, and the required cabling, instrumentation and protective features. Each channel is electrically and physically independent from the equipment of all other channels so that a single failure in one channel will not cause a failure in another channel. Each channel consists of a battery charger which supplies normal DC power, a battery for emergency DC power, and a battery board which facilitates load grouping and provides circuit protection. These four channels are used to provide emergency power to the 120V AC vital power system which furnishes control power to the reactor protection system. No automatic connections are used between the four ~~redundant~~ channels.

Battery boards I, II, III, and IV have a charger normally connected to them and also have manual access to a spare (backup) charger for use upon loss of the normal charger.

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

Additionally, battery boards I, II, III, and IV have manual access to the fifth vital battery system. The fifth 125V DC Vital Battery System is intended to serve as a replacement for any one of the four 125V DC vital batteries during their testing, maintenance, and outages with no loss of system reliability under any mode of operation.

Each of the vital DC electrical power subsystems provides the control power for its associated Class 1E AC power load group, 6.9 kV switchgear, and 480 V load centers. The vital DC electrical power subsystems also provide DC electrical power to the inverters, which in turn power the AC vital buses. Additionally, they power the emergency DC lighting system.

The vital DC power distribution system is described in more detail in Bases for LCO 3.8.9, “Distribution System - Operating,” and LCO 3.8.10, “Distribution Systems - Shutdown.”

~~Each vital battery has adequate storage capacity to carry the required load continuously for at least 4 hours in the event of a loss of all AC power (station blackout) without an accident or for 30 minutes with an accident considering a single failure. Load shedding of non-required loads will be performed to achieve the required coping duration for station blackout conditions.~~

Each 125 VDC vital battery is separately housed in a ventilated room apart from its charger and distribution centers, except for Vital Battery V. Each subsystem is located in an area separated physically and electrically from the other subsystem to ensure that a single failure in one subsystem does not cause a failure in a redundant subsystem. There is no sharing between ~~redundant~~ Class 1E subsystems, such as batteries, battery chargers, or distribution panels.

Each battery has adequate storage capacity to meet the duty cycle(s) discussed in the FSAR, Chapter 8 (Ref 4). The battery is designed with additional capacity above that required by the design duty cycle to allow for temperature variations and other factors.

The batteries for the vital DC electrical power subsystems are sized to produce required capacity at 80% of nameplate rating, corresponding to warranted capacity at end of life cycles, ~~de-rated for minimum ambient temperature~~ and the 100% design demand. The minimum design voltage limit is 105 V.~~The voltage limit is 2.13 V per cell, which corresponds to a total minimum voltage output of 128 V per battery (132 V for Vital Battery V). The criteria for sizing large lead storage batteries are defined in IEEE-485 (Ref. 5).~~

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for a 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 4).

Each Vital DC electrical power subsystem battery charger has ample power output capacity for the steady state operation of connected loads required during normal operation, while at the same time maintaining its battery bank fully charged. Each battery charger also has sufficient excess capacity to restore the battery bank from the design minimum charge to its fully charged state within 12 hours (with accident loads being supplied) following a 30 minute AC power outage and in approximately 36 hours (while supplying normal steady state loads following a 2 hour AC power outage), (Ref. ~~6~~5).

The battery charger is normally in the float-charge mode. Float-charge is the condition in which the charger is supplying the connected loads and the battery cells are receiving adequate current to optimally charge the battery. This assures the internal losses of a battery are overcome and the battery is maintained in a fully charged state.

When desired, the charger can be placed in the equalize mode. The equalize mode is at a higher voltage than the float mode and charging current is correspondingly higher. The battery charger is operated in the equalize mode after a battery discharge or for routine maintenance. Following a battery discharge, the battery recharge characteristic accepts current at the current limit of the battery charger (if the discharge was significant, e.g., following a battery service test) until the battery terminal voltage approaches the charger voltage setpoint. Charging current then reduces exponentially during the remainder of the recharge cycle. Lead-calcium batteries have recharge efficiencies of greater than 95%, so once at least 105% of the ampere-hours discharged have been returned, the battery capacity would be restored to the same condition as it was prior to the discharge. This can be monitored by direct observation of the exponentially decaying charging current or by evaluating the amp-hours discharged from the battery and amp-hours returned to the battery.

BASES

BACKGROUND (continued)

125 V Diesel Generator (DG) DC Electrical Power Subsystem

Control power for the DGs is provided by four DG battery systems, one per DG. Each system is comprised of a battery, a battery charger, distribution center, cabling, and cable ways. The DG 125V DC control power and field-flash circuits have power supplied from their respective 125V distribution panel. The normal supply of DC current is from the associated charger. The battery provides control and field-flash power when the charger is unavailable. The charger supplies the normal DC loads, maintains the battery in a fully charged condition, and recharges (480V AC available) the battery while supplying the required loads regardless of the status of the unit. The batteries are physically and electrically independent. The battery has sufficient capacity when fully charged to supply required loads for a minimum of four hours following a loss of normal power. Each battery is normally required to supply loads during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from its respective DG.

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. ~~7~~6), and in the FSAR, Section 15 (Ref. ~~7~~6), assume that Engineered Safety Feature (ESF) systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining the DC sources OPERABLE during accident conditions in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

The DC sources satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

BASES (continued)

LCO

~~Four~~ Two 125V vital DC electrical power subsystems (Train A and Train B), each vital subsystem consisting of two channels. Each channel consisting of a battery bank, associated battery charger and the corresponding control equipment and interconnecting cabling supplying power to the associated DC bus within the channel; and ~~four~~ one DG DC electrical power ~~sub~~system~~s~~ for each DG, consisting of a battery, a dual battery charger assembly, and the corresponding control equipment and interconnecting cabling are required to be OPERABLE to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence (A00) or a postulated DBA. Loss of any DC electrical power subsystem does not prevent the minimum safety function from being performed (Ref. 4).

An OPERABLE vital DC electrical power subsystem requires all required batteries and respective chargers to be operating and connected to the associated DC buses.

Each DG DC electrical power system is independent and dedicated to its respective DG. The DGs that are supported by the DG DC electrical power systems are arranged in redundant trains (i.e., DG 1A-A and DG 2A-A are in Train A, and DG 1B-B and DG 2B-B are in Train B). When one or two DGs in a train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Likewise, if one or two of the DG DC electrical power systems that support the DGs in that train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Therefore, the LCO requires two DG DC electrical power trains to be OPERABLE to support the redundancy of the standby electrical power system.

The LCO is modified by one Note. The Note indicates that Vital Battery V may be substituted for any of the required vital batteries. However, the fifth battery cannot be declared OPERABLE until it is connected electrically in place of another battery and it has satisfied applicable Surveillance Requirements.

APPLICABILITY

The ~~four~~ vital DC electrical power sources and ~~four~~ DG DC electrical power sources are required to be OPERABLE in MODES 1, 2, 3, and 4 to ensure safe plant operation and to ensure that:

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOs or abnormal transients; and

b. Adequate core cooling is provided, and containment integrity and other vital functions are maintained in the event of a postulated DBA.

The DC electrical power requirements for MODES 5 and 6 are addressed in the Bases for LCO 3.8.5, “DC Sources - Shutdown.”

BASES (continued)

ACTIONS

A.1, A.2, and A.3

Condition A represents one vital DC subsystem with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action A.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage. Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action A.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action A.2).

Required Action A.2 requires that the battery float current be verified as less than or equal to 2 amps. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement.

(continued)

BASES (continued)

ACTIONS

A.1, A.2, and A.3 (continued)

The 2 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 2 amps this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action A.3 limits the restoration time for the inoperable battery charger to 7 days. This action is applicable if an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage has been used (e.g., balance of plant non-Class 1E battery charger). The 7 day Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

~~A~~B.1

Condition ~~A~~B represents one vital ~~channel~~ DC electrical power subsystem with a loss of ability to completely respond to an event, and a potential loss of ability to remain energized during normal operation. It is, therefore, imperative that the operator's attention focus on stabilizing the plant, minimizing the potential for complete loss of DC power to the affected ~~train~~ subsystem. The 2 hour limit is consistent with the allowed time for an inoperable DC distribution subsystem ~~train~~.

If one of the required vital DC electrical power subsystems is inoperable for reasons other than Condition A (e.g., ~~inoperable battery, inoperable battery charger(s), or~~ inoperable battery charger and associated inoperable battery), the remaining vital DC electrical power subsystem has the capacity to support a safe shutdown and to mitigate an accident condition. Since a subsequent worst case single failure of the OPERABLE subsystem ~~would~~ could, however, result in ~~a situation where the ability of the 125V DC electrical power subsystem to support its required ESF function is not assured,~~ the loss of the minimum necessary vital DC electrical power subsystems to mitigate a worst-case accident, continued power operation should not exceed 2 hours. The 2 hour Completion Time is based on Regulatory Guide 1.93 (Ref. ~~8~~7) and reflects a reasonable time to assess plant status as a function of the inoperable vital DC electrical power subsystem and, if the vital DC electrical power subsystem is not restored to OPERABLE status, to prepare to effect an orderly and safe plant shutdown.

(continued)

BASES

ACTIONS (continued)

~~B.1 and B.2~~C,1 and C.2

If the inoperable vital DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The Completion Time to bring the plant to MODE 5 is consistent with the time required in Regulatory Guide 1.93 (Ref. ~~8~~7).

D.1, D.2, and D.3

Condition D represents one DG DC train with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action D.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage.

Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DG DC system is designed for.

ACTIONS

D.1, D.2, and D.3 (continued)

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2).

Required Action D.2 requires that the battery float current be verified as less than or equal to 1 amp. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 1 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 1 amp this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action D.3 limits the restoration time for the inoperable battery charger to 72 hours. The 72 hour Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

~~C.1~~E.1

Condition ~~C~~E represents one DG with a loss of ability to completely respond to an event. Since a subsequent single failure on the opposite train could result in a situation where the required ESF function is not assured, continued power operation should not exceed 2 hours. The 2 hour time limit is consistent with the allowed time for an inoperable vital DC electrical power subsystem.

~~D.1~~F.1

If the DG DC electrical power subsystem cannot be restored to OPERABLE status in the associated Completion Time, the associated DG may be incapable of performing its intended function and must be immediately declared inoperable. This declaration also requires entry into applicable Conditions and Required Actions for an inoperable DG, LCO 3.8.1, "AC Sources-Operating."

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1 and SR 3.8.4.2

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the battery chargers, which support the ability of the batteries to perform their intended function ~~charging system and the ability of the batteries to perform their intended function~~. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery ~~(or battery cell)~~ and maintain the battery ~~(or a battery cell)~~ in a fully charged state while supplying the continuous steady state loads of the associated DC subsystem. On float charge, battery cells will receive adequate current to optimally charge the battery. The voltage requirements are based on the ~~critical~~ nominal design voltage of the battery and are consistent with the ~~initial voltages assumed in the battery sizing calculations~~ minimum float voltage established by the battery manufacturer (2.20 Vpc times the number of connected cells or 132 V at the battery terminals for a 60 cell vital battery; 127.6 V at the battery terminals for a 58 cell DG battery). This voltage maintains the battery plates in a condition that supports maintaining the grid life. The 7 day Frequency is consistent with manufacturer recommendations ~~and IEEE-450 (Ref. 9)~~.

SR 3.8.4.3

Verifying that for the vital batteries that the alternate feeder breakers to each required battery charger is open ensures that independence between the power trains is maintained. The 7 day Frequency is based on engineering judgment, is consistent with procedural controls governing breaker operation, and ensures correct breaker position.

SR 3.8.4.4

This SR demonstrates that the DG 125V DC distribution panel and associated charger are functioning properly, with all required circuit breakers closed and buses energized from normal power. The 7 day Frequency takes into account the redundant DG capability and other indications available in the control room that will alert the operator to system malfunctions.

~~SR 3.8.4.5 and SR 3.8.4.6~~

~~Visual inspection to detect corrosion of the battery cells and connections, or measurement of the resistance of each intercell, interrack, intertier, and terminal connection, provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance.~~

~~The limits established for this SR must be no more than 20% above the resistance as measured during installation, or not above the ceiling value~~

(continued)

BASES

SURVEILLANCE REQUIREMENTS

~~SR 3.8.4.5 and SR 3.8.4.6 (continued)~~

~~established by the manufacturer.~~

~~The Surveillance Frequency for these inspections, which can detect conditions that can cause power losses due to resistance heating, is 92 days. This Frequency is considered acceptable based on operating experience related to detecting corrosion trends.~~

~~SR 3.8.4.7~~

~~Visual inspection of the battery cells, cell plates, and battery racks provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance.~~

~~The 12 month Frequency for this SR is consistent with IEEE-450 (Ref. 9), which recommends detailed visual inspection of cell condition and rack integrity on a yearly basis.~~

~~SR 3.8.4.8, SR 3.8.4.9 and SR 3.8.4.10~~

~~Visual inspection and resistance measurements of intercell, interrack, intertier, and terminal connections provide an indication of physical damage or abnormal deterioration that could indicate degraded battery condition. The anticorrosion material is used to help ensure good electrical connections and to reduce terminal deterioration. The visual inspection for corrosion is not intended to require removal of and inspection under each terminal connection. The removal of visible corrosion is a preventive maintenance SR. The presence of visible corrosion does not necessarily represent a failure of this SR provided visible corrosion is removed during performance of SR 3.8.4.8. For the purposes of trending, inter-cell (vital and DG batteries) and inter-tier (vital and DG batteries) connections are measured from battery post to battery post. Inter-rack (vital batteries), inter-tier (DG Batteries), and terminal connections (vital and DG batteries) are measured from terminal lug to battery post.~~

~~The connection resistance limits for SR 3.8.4.9 and SR 3.8.4.10 shall be no more than 20% above the resistance as measured during installation, or not above the ceiling value established by the manufacturer.~~

~~The Surveillance Frequencies of 12 months is consistent with IEEE-450 (Ref. 9), which recommends cell to cell and terminal connection resistance measurement on a yearly basis.~~

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.4.115

This SR requires that each vital battery charger be capable of recharging its associated battery from a capacity or service discharge test while supplying normal loads, or alternatively, operating at current limit for a minimum of 4 hours at a nominal 125 VDC. These requirements are based on verifies the design capacity of the vital battery chargers (Ref. 4) and their performance characteristic of current limit operation for a substantial portion of the recharge period. Battery charger output current is limited to 110% - 125% of the 200 amp rated output. Recharging the battery or testing for a minimum of 4 hours is sufficient to verify the output capability of the charger can be sustained, that current limit adjustments are properly set and that protective devices will not inhibit performance at current limit settings. According to Regulatory Guide 1.32 (Ref. 65), the battery charger supply is required recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. Verifying the capability of the charger to operate in a sustained current limit condition The minimum required amperes and duration ensures that these requirements can be satisfied.

This SR provides two options. One option requires that each battery charger be capable of supplying 200 amps at the minimum established float voltage (132 V DC) for 4 hours. The ampere requirements are based on the output rating of the chargers. The voltage requirements are based on the charger voltage level after a response to a loss of AC power.

The other option requires that each vital battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 2 amps.

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

This SR is modified by a Note. The reason for the Note is that performing the Surveillance may perturb the electrical distribution system and challenge safety systems. This Surveillance is normally performed during MODES 5 and 6 since it would require the DC

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.~~11~~5 (continued)

~~electrical power subsystem to be inoperable during performance of the test. However, this Surveillance may be performed in MODES 1, 2, 3, or 4 provided the Vital Battery V is substituted in accordance with LCO Note 1. Credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:~~

~~1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and~~

~~2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.~~

SR 3.8.4.~~12~~6

This SR ~~requires that each diesel generator battery charger be capable of recharging its associated battery from a capacity or service discharge test while supplying normal loads, or alternatively, operating at current limit for a minimum of 4 1/2 hours at a nominal 125 VDC. This requirement is based on~~ verifies the design capacity of the DG battery chargers ~~(Ref. 13) and their performance characteristic of current limit operation for a substantial portion of the recharge period. Battery charger output current is limited to a maximum of 140% of the 20 amp rated output. Recharging the battery verifies the output capability of the charger can be sustained, that current limit adjustments are properly set and that protective devices will not inhibit performance at current limit settings~~. According to Regulatory Guide 1.32 (Ref. ~~6~~5), the battery charger supply is ~~required~~ recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. ~~Verifying the capability of the charger to operate in a sustained current limit condition~~ The minimum required amperes and duration ensure~~s~~ that these requirements can be satisfied.

This SR requires that each DG battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur).

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.126 (continued)

This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 1 amp.

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

For the DG DC electrical subsystem, this Surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the DG DC electrical power subsystem supplies loads only for the inoperable diesel generator and would not otherwise challenge safety systems supplied from vital electrical distribution systems. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

SR 3.8.4.137

A battery service test is a special test of battery capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The discharge rate and test length should correspond to worst case design duty cycle requirements based on References 108 and 1210.

The Surveillance Frequency of 18 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. 65) and Regulatory Guide 1.129 (Ref. 119), which state that the battery service test should be performed during refueling operations or at some other outage, with intervals between tests, not to exceed 18 months.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.137 (continued)

This SR is modified by two Notes. Note 1 allows the performance of a modified performance discharge test in lieu of a service test once per 60 months. The modified performance discharge test is a simulated duty cycle consisting of just two rates; the one minute rate published for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a rated one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test should remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.

A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle.) This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

The reason for Note 2 is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES 1, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note 1. For the DG DC electrical subsystem, this surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.4.14

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

A battery modified performance discharge test is described in the Bases for 3.8.4.13. Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.4.14; however, only the modified performance discharge test may be used to satisfy SR 3.8.4.14 while satisfying the requirements of SR 3.8.4.13 at the same time.

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 9) and IEEE-485 (Ref. 5). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements.

The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's rating. Degradation is indicated, according to IEEE-450 (Ref. 9), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 9).

This SR is modified by a Note. The reason for the Note is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES 1, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note 1. For the DG DC electrical subsystem, this surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available;

(continued)

BASES

SURVEILLANCE REQUIREMENTS

~~SR 3.8.4.14 (continued)~~

~~and~~

~~2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.~~

(continued)

BASES

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, Appendix A, General Design Criterion 17, “Electric Power System.”

2. Regulatory Guide 1.6, “Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems,” U.S. Nuclear Regulatory Commission, March 10, 1971.

3. IEEE-308-1971, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” Institute of Electrical and Electronic Engineers.

4. Watts Bar FSAR, Section 8.3.2, “DC Power System.”

~~5. IEEE-485-1983, “Recommended Practices for Sizing Large Lead Storage Batteries for Generating Stations and Substations,” Institute of Electrical and Electronic Engineers.~~

~~6~~5. Regulatory Guide 1.32, “Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants,” February 1977, U.S. Nuclear Regulatory Commission.

~~7~~6. Watts Bar FSAR, Section 15, “Accident Analysis” and Section 6 “Engineered Safety Features.”

~~8~~7. Regulatory Guide 1.93, “Availability of Electric Power Sources,” U.S. Nuclear Regulatory Commission, December 1974.

~~9. IEEE-450-1980/1995, “IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented Lead - Acid Batteries for Stationary Applications,” Institute of Electrical and Electronics Engineers, Inc.~~

~~10~~8. TVA Calculation EDQ00023620070003, “125V DC Vital Battery System Analysis”

~~11~~9. Regulatory Guide 1.129, “Maintenance Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Subsystems,” U.S. Nuclear Regulatory Commission, February 1978.

~~12~~10. TVA Calculation WBN EEB-EDQ00023620070003, “125V DC Vital Battery System Analysis.”

~~13. Watts Bar FSAR, Section 8.3.1, “AC Power System.”~~

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.6 Battery Cell Parameters

BASES

BACKGROUND

This LCO delineates the limits on battery float current, electrolyte temperature, electrolyte level, and cell float voltage for the 125V vital DC electrical power subsystem and the diesel generator (DG) batteries. A discussion of these batteries and their OPERABILITY requirements is provided in the Bases for LCO 3.8.4, "DC Sources - Operating," and LCO 3.8.5, "DC Sources - Shutdown." In addition to the limitations of this Specification, the Battery Monitoring and Maintenance Program also implements a program specified in Specification 5.7.2.22 for monitoring various battery parameters.

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 3).

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 1) and Section 15 (Ref. 1), assume Engineered Safety Feature systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining at least one train subsystem of DC sources OPERABLE during accident conditions, in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

Battery parameters satisfy the Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

Battery parameters must remain within acceptable limits to ensure availability of the required DC power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. ~~Electrolyte~~ Battery parameter limits are conservatively established, allowing continued DC electrical system function even with ~~Category A and B~~ limits not met. Additional preventative maintenance, testing, and monitoring performed in accordance with the Battery Monitoring and Maintenance Program is conducted as specified in Specification 5.7.2.22.

APPLICABILITY

The battery ~~cell~~ parameters are required solely for the support of the associated vital DC and DG DC electrical power subsystems. Therefore, battery ~~electrolyte is~~ parameter limits are only required when the DC power source is required to be OPERABLE. Refer to the Applicability discussion in Bases for LCO 3.8.4 and LCO 3.8.5.

ACTIONS

~~A.1, A.2, and A.3~~

~~With one or more cells in one or more batteries not within limits (i.e., Category A limits not met, Category B limits not met, or Category A and B limits not met) but within the Category C limits specified in Table 3.8.6-1 in the accompanying LCO, the battery is degraded but there is still sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of Category A or B limits not met, and operation is permitted for a limited period.~~

~~The pilot cell electrolyte level and float voltage are required to be verified to meet the Category C limits within 1 hour (Required Action A.1). This check will provide a quick indication of the status of the remainder of the battery cells. One hour provides time to inspect the electrolyte level and to confirm the float voltage of the pilot cells. One hour is considered a reasonable amount of time to perform the required verification.~~

~~Verification that the Category C limits are met (Required Action A.2) provides assurance that during the time needed to restore the parameters to the Category A and B limits, the battery is still capable of performing its intended function. A period of 24 hours is allowed to complete the initial verification because specific gravity measurements must be obtained for each connected cell. Taking into consideration both the time required to perform the required verification and the assurance that the battery cell parameters are not severely degraded, this time is considered reasonable. The verification is repeated at 7 day intervals until the parameters are restored to Category A and B limits. This periodic verification is consistent with the normal Frequency of pilot cell surveillances.~~

(continued)

BASES

ACTIONS

A.1, A.2, and A.3 (continued)

Continued operation is only permitted for 31 days before battery cell parameters must be restored to within Category A and B limits. With the consideration that, while battery capacity is degraded, sufficient capacity exists to perform the intended function and to allow time to fully restore the battery cell parameters to normal limits, this time is acceptable prior to declaring the battery inoperable.

A.1, A.2, and A.3

With one or more cells in one or more batteries in one vital DC subsystem < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.1) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.1). This assures that there is still sufficient battery capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.1 or SR 3.8.6.1 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.1 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

B.1 and B.2

One or more batteries in one vital DC subsystem with float current > 2 amps indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition A addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and

(continued)

BASES

ACTIONS

B.1 and B.2 (continued)

the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action B.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.4.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

C.1, C.2, and C.3

With one or more cells in one or more batteries in one DG DC train < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.2) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.2). This assures that there is still sufficient battery capacity to perform the intended function.

Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

(continued)

BASES

ACTIONS

C.1, C.2, and C.3 (continued)

Since the Required Actions only specify "perform," a failure of SR 3.8.4.2 or SR 3.8.6.2 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.2 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

D.1 and D.2

One or more batteries in one DG DC train with float current > 1 amp indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition B addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

(continued)

BASES

ACTIONS

D.1 and D.2 (continued)

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action D.1 only specifies "perform," a failure of SR 3.8.4.2 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.2 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

E.1, E.2, and E.3

With one or more required batteries in one vital DC subsystem or one or more DG batteries in one train with one or more cells electrolyte level above the top of the plates, but below the minimum established design limits, the battery still retains sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of electrolyte level not met. Within 31 days the minimum established design limits for electrolyte level must be re-established.

With electrolyte level below the top of the plates there is a potential for dryout and plate degradation. Required Actions E.1 and E.2 address this potential (as well as provisions in Specification 5.7.2.22, Battery Monitoring and Maintenance Program). They are modified by a Note that indicates they are only applicable if electrolyte level is below the top of the plates. Within 8 hours level is required to be restored to above the top of the plates. The Required Action E.2 requirement to verify that there is no leakage by visual inspection and the Specification 5.7.2.22.b item to initiate action to equalize and test in accordance with manufacturer's recommendation. They are performed following the restoration of the electrolyte level to above the top of the plates. Based on the results of the manufacturer's recommended testing the battery(ies) may have to be declared inoperable and the affected cell(s) replaced.

F.1

With one or more batteries in one vital DC subsystem or one or more DG batteries in one train with pilot cell temperature less than the minimum established design limits, 12 hours is allowed to restore the temperature to within limits. A low electrolyte temperature limits the current and power available. Since the battery is sized with margin, while battery capacity is degraded, sufficient capacity exists to perform the intended function and the affected battery is not required to be considered inoperable solely as a result of the pilot cell temperature not met.

(continued)

BASES

ACTIONS (continued)

G.1

With one or more vital batteries in redundant DC subsystems with battery parameters not within limits there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function, given that redundant batteries are involved. With redundant batteries involved this potential could result in a total loss of function on multiple systems that rely upon the batteries.

The longer Completion Times specified for vital battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one subsystem within 2 hours.

H.1

With one or more DG batteries in redundant DG trains with battery parameters not within limits, there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function. With batteries in redundant DG trains involved, this potential could result in a total loss of function for DGs that rely upon the batteries.

The longer Completion Times specified for battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one train within 2 hours.

~~B~~I.1

With one or more batteries with ~~one or more~~ any battery ~~cell~~ parameter~~s~~ outside the ~~Category C limits for any connected cell,~~ allowances of the Required Actions for Condition A, B, C, D, E, F, G, or H, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding ~~vital DC or DG DC electrical power subsystem~~ battery must be declared inoperable. Additionally, ~~other potentially extreme conditions, such as not completing the Required Actions of Condition A within the required Completion Time or average electrolyte temperature of representative cells falling below 60°F for the vital batteries or 50°F for DG batteries, are also cause for immediately declaring the associated vital DC or DG DC electrical power subsystem inoperable.~~ discovering one or more vital DC batteries in one subsystem with one or more battery cells float voltage less than 2.07 V and float current greater than 2 amps, or one or more DG batteries in one train with one or more battery cells float voltage greater than or equal to 2.07 V and float current greater than 1 amp, indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1

This SR verifies that Category A battery cell parameters are consistent with IEEE-450 (Ref. 2), which recommends regular battery inspections (at least one per month) including voltage, specific gravity, and electrolyte temperature of pilot cells.

SR 3.8.6.2

The quarterly inspection of specific gravity and voltage is consistent with IEEE-450 (Ref. 2). In addition, within 24 hours of a battery discharge < 110 V (113.5V for Vital Battery V or 106.5 for DG batteries) or a battery overcharge > 150 V (155 V for Vital Battery V or 145 V for DG batteries), the battery must be demonstrated to meet Category B limits. Transients, such as motor starting transients, which may momentarily cause battery voltage to drop to ≤ 110 V (113.5 V for Vital Battery V or 106.5 V for DG batteries), do not constitute a battery discharge provided the battery terminal voltage and float current return to pre-transient values. This inspection is also consistent with IEEE-450 (Ref. 2), which recommends special inspections following a severe discharge or overcharge, to ensure that no significant degradation of the battery occurs as a consequence of such discharge or overcharge.

SR 3.8.6.3

This Surveillance verification that the average temperature of representative cells is ≥ 60°F for the vital batteries and ≥ 50°F for the DG batteries, is consistent with a recommendation of IEEE-450 (Ref. 2), that states that the temperature of electrolytes in representative cells should be determined on a quarterly basis.

Lower than normal temperatures act to inhibit or reduce battery capacity. This SR ensures that the operating temperatures remain within an acceptable operating range. This limit is based on manufacturer recommendations.

Table 3.8.6-1

This table delineates the limits on electrolyte level, float voltage, and specific gravity for three different categories. The meaning of each category is discussed below.

Category A defines the normal parameter limit for each designated pilot cell in each battery. The cells selected as pilot cells are those whose temperature, voltage, and electrolyte specific gravity approximate the state of charge of the entire battery.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

The Category A limits specified for electrolyte level are based on manufacturer recommendations and are consistent with the guidance in IEEE-450 (Ref. 2), with the extra ¼ inch allowance above the high water level indication for operating margin to account for temperatures and charge effects. In addition to this allowance, footnote a to Table 3.8.6-1 permits the electrolyte level to be above the specified maximum level during equalizing charge, provided it is not overflowing. These limits ensure that the plates suffer no physical damage, and that adequate electron transfer capability is maintained in the event of transient conditions. IEEE-450 (Ref. 2) recommends that electrolyte level readings should be made only after the battery has been at float charge for at least 72 hours.

The Category A limit specified for float voltage is ≥ 2.13 V per cell. This value is based on the recommendations of IEEE-450 (Ref. 2), which states that prolonged operation of cells < 2.13 V can reduce the life expectancy of cells.

The Category A limit specified for specific gravity for each pilot cell is ≥ 1.200 (0.015 below the manufacturer fully charged nominal specific gravity or a battery charging current that had stabilized at a low value). This value is characteristic of a charged cell with adequate capacity. According to IEEE-450 (Ref. 2), the specific gravity readings are based on a temperature of 77°F (25°C).

The specific gravity readings are corrected for actual electrolyte temperature and level. For each 3°F (1.67°C) above 77°F (25°C), 1 point (0.001) is added to the reading; 1 point is subtracted for each 3°F below 77°F. The specific gravity of the electrolyte in a cell increases with a loss of water due to electrolysis or evaporation.

Category B defines the normal parameter limits for each connected cell. The term "connected cell" excludes any battery cell that may be jumpered out.

The Category B limits specified for electrolyte level and float voltage are the same as those specified for Category A and have been discussed above. The Category B limit specified for specific gravity for each connected cell is ≥ 1.195 (0.020 below the manufacturer fully charged, nominal specific gravity) with the average of all connected cells > 1.205 (0.010 below the manufacturer fully charged, nominal specific gravity). These values are based on manufacturer's recommendations. The minimum specific gravity value required for each cell ensures that the effects of a highly charged or newly installed cell will not mask overall degradation of the battery.

(continued)

SURVEILLANCE REQUIREMENTS (continued)

Category C defines the limits for each connected cell. These values, although reduced, provide assurance that sufficient capacity exists to perform the intended function and maintain a margin of safety. When any battery parameter is outside the Category C limits, the assurance of sufficient capacity described above no longer exists, and the battery must be declared inoperable.

The Category C limits specified for electrolyte level (above the top of the plates and not overflowing) ensure that the plates suffer no physical damage and maintain adequate electron transfer capability. The Category C limits for float voltage is based on IEEE-450 (Ref. 2), which states that a cell voltage of 2.07 V or below, under float conditions and not caused by elevated temperature of the cell, indicates internal cell problems and may require cell replacement.

The Category C limits of average specific gravity ≥ 1.195 is based on manufacturer recommendations (0.020 below the manufacturer recommended fully charged, nominal specific gravity). In addition to that limit, it is required that the specific gravity for each connected cell must be no less than 0.020 below the average of all connected cells. This limit ensures that the effect of a highly charged or new cell does not mask overall degradation of the battery.

The footnotes to Table 3.8.6-1 are applicable to Category A, B, and C specific gravity. Footnote b to Table 3.8.6-1 requires the above mentioned correction for electrolyte level and temperature, with the exception that level correction is not required when battery charging current is < 2 amps on float charge for vital batteries and < 1.0 amps for DG batteries. This current provides, in general, an indication of overall battery condition.

Because of specific gravity gradients that are produced during the recharging process, delays of several days may occur while waiting for the specific gravity to stabilize. A stabilized charger current is an acceptable alternative to specific gravity measurement for determining the state of charge. This phenomenon is discussed in IEEE-450 (Ref. 2). Footnote c to Table 3.8.6-1 allows the float charge current to be used as an alternate to specific gravity for up to 31 days following a battery recharge. Within 31 days each connected cell's specific gravity must be measured to confirm the state of charge. Following a minor battery recharge (such as equalizing charge that does not follow a deep discharge) specific gravity gradients are not significant, and confirming measurements may be made in less than 31 days.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1 and SR 3.8.6.2

Verifying battery float current while on float charge is used to determine the state of charge of the battery. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The equipment used to monitor float current must have the necessary accuracy and capability to measure electrical currents in the expected range. The float current requirements are based on the float current indicative of a charged battery. The 7 day Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.1 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION A are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 2 amps is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.2 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION D are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 1 amp is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.3 and SR 3.8.6.6

Optimal long term battery performance is obtained by maintaining a float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer, which corresponds to 132 V at the battery terminals, or 2.20 Vpc. This provides adequate overpotential, which limits the formation of lead sulfate and self discharge, which could eventually render the battery inoperable. Float voltages in this range or less, but greater than 2.07 Vpc, are addressed in Specification 5.7.2.22. SRs 3.8.6.3 and 3.8.6.6 require verification that the cell float voltages are equal to or greater than the short term absolute minimum voltage of 2.07 V. The Frequency for cell voltage verification every 31 days for pilot cell and 92 days for each connected cell is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.4

The limit specified for electrolyte level ensures that the plates suffer no physical damage and maintains adequate electron transfer capability. The minimum design electrolyte level is the minimum level indication mark on the battery cell jar. The Frequency is consistent with IEEE-450 (Ref. 2).

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.6.5

This Surveillance verifies that the pilot cell temperature is greater than or equal to the minimum established design limit (i.e., 60°F for vital batteries and 50°F for DG batteries). Pilot cell electrolyte temperature is maintained above this temperature to assure the battery can provide the required current and voltage to meet the design requirements. Temperatures lower than assumed in battery sizing calculations act to inhibit or reduce battery capacity. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.7

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.6.7; however, only the modified performance discharge test may be used to satisfy the battery service test requirements of SR 3.8.4.7.

A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle). This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

It may consist of just two rates; for instance the one minute rate for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test must remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 2) and IEEE-485 (Ref. 4). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer's rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements. Furthermore, the battery is sized to meet the assumed duty cycle loads when the battery design capacity reaches this 80% limit.

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SURVEILLANCE REQUIREMENTS

SR 3.8.6.7 (continued)

The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's ratings. Degradation is indicated, according to IEEE-450 (Ref. 2), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer's rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 2).

This SR is modified by a Note. The reason for the Note is that performing the Surveillance would perturb the electrical distribution system and challenge safety systems. Credit may be taken for unplanned events that satisfy this SR.

REFERENCES

1. Watts Bar FSAR, Section 15, “Accident Analysis,” and Section 6, “Engineered Safety Features.”

2. IEEE-450-1980/19952002, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Vented Lead-Acid Storage Batteries for Generating Stations and SubstationsStationary Applications."

3. Watts Bar FSAR, Section 8, “Electric Power.”

4. IEEE-485-1983, "IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations."

Enclosure 3

Clean Technical Specification and Bases Changes

WBN Unit 1 Clean Technical Specification and Bases

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources - Operating

LCO 3.8.4 The Train A and Train B vital DC and Diesel Generator (DG) DC electrical power subsystems shall be OPERABLE.

---NOTE---
Vital Battery V may be substituted for any of the required vital batteries.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery charger(s) on one subsystem inoperable.	A.1 Restore battery terminal voltage to greater than or equal to the minimum established float voltage.	2 hours
	<u>AND</u>	
	A.2 Verify battery float current ≤ 2 amps.	Once per 12 hours
	<u>AND</u>	
	A.3 Restore vital battery charger(s) to OPERABLE status.	7 days
B. One vital DC electrical power subsystem inoperable for reasons other than Condition A.	B.1 Restore vital DC electrical power subsystem to OPERABLE status.	2 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Required Action and Associated Completion Time of Condition A or B not met.	C.1 Be in MODE 3. AND C.2 Be in MODE 5.	6 hours 36 hours
D. One or two DG DC battery charger(s) on one train inoperable.	D.1 Restore DG battery terminal voltage to greater than or equal to the minimum established float voltage. AND D.2 Verify battery float current ≤ 1 amp. AND D.3 Restore DG battery charger(s) to OPERABLE status.	2 hours Once per 12 hours 72 hours
E. One DG DC train inoperable for reasons other than Condition D.	E.1 Restore DG DC train to OPERABLE status.	2 hours
F. Required Action and associated Completion Time of Condition D or E not met.	F.1 Declare associated DG inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify vital battery terminal voltage is greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.2	Verify DG battery terminal voltage is greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.3	Verify for the vital batteries that the alternate feeder breakers to each required battery charger are open.	7 days
SR 3.8.4.4	Verify correct breaker alignment and indicated power availability for each DG 125 V DC distribution panel and associated battery charger.	7 days
SR 3.8.4.5	Verify each vital battery charger supplies ≥ 200 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours. OR Verify each vital battery charger can recharge the battery to the fully charged state within 36 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months
SR 3.8.4.6	------------------------------NOTE------------------------------ Credit may be taken for unplanned events that satisfy this SR. -- Verify each DG battery charger can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.7	------------------------------NOTES------------------------------ 1. The modified performance discharge test in SR 3.8.6.7 may be performed in lieu of the service test in SR 3.8.4.7. 2. This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --- Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads and any connected nonsafety loads for the design duty cycle when subjected to a battery service test.	18 months

3.8 ELECTRICAL POWER SYSTEMS

3.8.6 Battery Parameters

LCO 3.8.6 Battery parameters for Train A and Train B electrical power subsystem 125 V vital batteries and 125 V diesel generator (DG) batteries shall be within limits.

APPLICABILITY: When associated DC electrical power subsystems and DGs are required to be OPERABLE.

ACTIONS

---NOTE---
Separate Condition entry is allowed for each battery bank.

CONDITION		REQUIRED ACTION		COMPLETION TIME
A.	One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V.	A.1	Perform SR 3.8.4.1.	2 hours
		AND		
		A.2	Perform SR 3.8.6.1.	2 hours
		AND		
		A.3	Restore affected cell voltage ≥ 2.07 V.	24 hours
B.	One or two required vital battery(ies) on one subsystem with float current > 2 amps.	B.1	Perform SR 3.8.4.1.	2 hours
		AND		
		B.2	Restore vital battery float current to ≤ 2 amps.	12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V.	C.1 Perform SR 3.8.4.2. AND C.2 Perform SR 3.8.6.2. AND C.3 Restore affected cell voltage ≥ 2.07 V.	2 hours 2 hours 24 hours
D. One or two DG battery(ies) on one train with float current > 1 amp.	D.1 Perform SR 3.8.4.2. AND D.2 Restore vital battery float current to ≤ 1 amp.	2 hours 12 hours
------------------NOTE--------------------- Required Action E.2 shall be completed if electrolyte level was below the top of plates. --- E. One or two required vital battery(ies) on one subsystem with one or more cells electrolyte level less than minimum established design limits. OR One or two DG battery(ies) on one train with one or more cells electrolyte level less than minimum established design limits.	---------------------NOTE---------------------- Required Actions E.1 and E.2 are only applicable if electrolyte level was below the top of plates. --- E.1 Restore electrolyte level to above top of plates. AND E.2 Verify no evidence of leakage. AND E.3 Restore electrolyte level to greater than or equal to minimum established design limits.	 8 hours 12 hours 31 days

(continued)

ACTIONS (continued)

CONDITION		REQUIRED ACTION		COMPLETION TIME
F.	One or two required vital battery(ies) on one subsystem with pilot cell electrolyte temperature less than minimum established design limits. <u>OR</u> One or two DG battery(ies) on one train with pilot cell electrolyte temperature less than minimum established design limits.	F.1	Restore battery pilot cell temperature to greater than or equal to minimum established design limits.	12 hours
G.	One or more vital batteries in redundant subsystems with battery parameters not within limits.	G.1	Restore battery parameters for vital batteries in one subsystem to within limits.	2 hours
H.	One or more DG batteries in redundant trains with battery parameters not within limits.	H.1	Restore battery parameters for DG batteries in one train to within limits.	2 hours

(continued)

ACTIONS (continued)

CONDITION		REQUIRED ACTION		COMPLETION TIME
I.	Required Action and associated Completion Time of Condition A, B, C, D, E, F, G, or H not met. <u>OR</u> One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V and float current > 2 amps. <u>OR</u> One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V and float current > 1 amp.	I.1	Declare associated battery inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	------------------------------NOTE------------------------------ Not required to be met when vital battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. -- Verify each vital battery float current is ≤ 2 amps.	7 days
SR 3.8.6.2	------------------------------NOTE------------------------------ Not required to be met when DG battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. -- Verify each DG battery float current is ≤ 1 amp.	7 days
SR 3.8.6.3	Verify each required vital battery and each DG battery pilot cell float voltage is ≥ 2.07 V.	31 days
SR 3.8.6.4	Verify each required vital battery and each DG battery connected cell electrolyte level is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.5	Verify each required vital battery and each DG battery pilot cell temperature is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.6	Verify each required vital battery and each DG battery connected cell float voltage is ≥ 2.07 V.	92 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.6.7	-------------------------------NOTES------------------------------- This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --	
	Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.	60 months AND 12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating AND 24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.4 DC Sources - Operating

BASES

BACKGROUND

The station DC electrical power system provides the AC emergency power system with control power. It also provides both motive and control power to selected safety related equipment and preferred AC vital bus power (via inverters). As required by 10 CFR 50, Appendix A, GDC 17 (Ref. 1), the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. The DC electrical power system also conforms to the recommendations of Regulatory Guide 1.6 (Ref. 2) and IEEE-308 (Ref. 3).

125 V Vital DC Electrical Power Subsystem

The vital 125 VDC electrical power system is a Class IE system whose safety function is to provide control power for engineered safety features equipment, emergency lighting, vital inverters, and other safety-related DC powered equipment for the entire unit. The system capacity is sufficient to supply these loads and any connected nonsafety loads during normal operation and to permit safe shutdown and isolation of the reactor for the "loss of all AC power" condition. The system is designed to perform its safety function subject to a single failure.

The 125V DC vital power system is composed of the four channels (Channels I and III are associated with Train A and Channels II and IV are associated with Train B) and consists of four lead-acid-calcium batteries, eight battery chargers (including two pairs of spare chargers), four distribution boards, battery racks, and the required cabling, instrumentation and protective features. Each channel is electrically and physically independent from the equipment of all other channels so that a single failure in one channel will not cause a failure in another channel. Each channel consists of a battery charger which supplies normal DC power, a battery for emergency DC power, and a battery board which facilitates load grouping and provides circuit protection. These four channels are used to provide emergency power to the 120V AC vital power system which furnishes control power to the reactor protection system. No automatic connections are used between the four channels.

Battery boards I, II, III, and IV have a charger normally connected to them and also have manual access to a spare (backup) charger for use upon loss of the normal charger.

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

Additionally, battery boards I, II, III, and IV have manual access to the fifth vital battery system. The fifth 125V DC Vital Battery System is intended to serve as a replacement for any one of the four 125V DC vital batteries during their testing, maintenance, and outages with no loss of system reliability under any mode of operation.

Each of the vital DC electrical power subsystems provide the control power for its associated Class 1E AC power load group, 6.9 kV switchgear, and 480 V load centers. The vital DC electrical power subsystems also provide DC electrical power to the inverters, which in turn power the AC vital buses. Additionally, they power the emergency DC lighting system.

The vital DC power distribution system is described in more detail in Bases for LCO 3.8.9, "Distribution System - Operating," and LCO 3.8.10, "Distribution Systems - Shutdown."

Each 125 VDC vital battery is separately housed in a ventilated room apart from its charger and distribution centers, except for Vital Battery V. Each subsystem is located in an area separated physically and electrically from the other subsystem to ensure that a single failure in one subsystem does not cause a failure in a redundant subsystem. There is no sharing between Class 1E subsystems, such as batteries, battery chargers, or distribution panels.

Each battery has adequate storage capacity to meet the duty cycle(s) discussed in the FSAR, Chapter 8 (Ref 4). The battery is designed with additional capacity above that required by the design duty cycle to allow for temperature variations and other factors.

The batteries for the vital DC electrical power subsystems are sized to produce required capacity at 80% of nameplate rating, corresponding to warranted capacity at end of life cycles and the 100% design demand. The minimum design voltage limit is 105 V.

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for a 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 132 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 4).

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

Each Vital DC electrical power subsystem battery charger has ample power output capacity for the steady state operation of connected loads required during normal operation, while at the same time maintaining its battery bank fully charged. Each battery charger also has sufficient excess capacity to restore the battery bank from the design minimum charge to its fully charged state within 12 hours (with accident loads being supplied) following a 30 minute AC power outage and in approximately 36 hours (while supplying normal steady state loads following a 2 hour AC power outage), (Ref. 5).

The battery charger is normally in the float-charge mode. Float-charge is the condition in which the charger is supplying the connected loads and the battery cells are receiving adequate current to optimally charge the battery. This assures the internal losses of a battery are overcome and the battery is maintained in a fully charged state.

When desired, the charger can be placed in the equalize mode. The equalize mode is at a higher voltage than the float mode and charging current is correspondingly higher. The battery charger is operated in the equalize mode after a battery discharge or for routine maintenance. Following a battery discharge, the battery recharge characteristic accepts current at the current limit of the battery charger (if the discharge was significant, e.g., following a battery service test) until the battery terminal voltage approaches the charger voltage setpoint. Charging current then reduces exponentially during the remainder of the recharge cycle. Lead-calcium batteries have recharge efficiencies of greater than 95%, so once at least 105% of the ampere-hours discharged have been returned, the battery capacity would be restored to the same condition as it was prior to the discharge. This can be monitored by direct observation of the exponentially decaying charging current or by evaluating the amp-hours discharged from the battery and amp-hours returned to the battery.

125 V Diesel Generator (DG) DC Electrical Power Subsystem

Control power for the DGs is provided by five DG battery systems, one per DG. Each system is comprised of a battery, a dual battery charger assembly, distribution center, cabling, and cable ways. The DG 125V DC control power and field-flash circuits have power supplied from their respective 125V distribution panel. The normal supply of DC current is from the associated charger. The battery provides control and field-flash power when the charger is unavailable. The charger supplies the normal DC loads, maintains the battery in a fully charged condition, and recharges (480V AC available) the battery while supplying the required loads regardless of the status of the unit. The batteries are physically and electrically independent. The battery has sufficient capacity when fully charged to supply required loads for a minimum of 30 minutes following a loss of normal power. Each battery is normally required to supply loads during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from its respective DG.

(continued)

BASES

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 6), and in the FSAR, Section 15 (Ref. 6), assume that Engineered Safety Feature (ESF) systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining the DC sources OPERABLE during accident conditions in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

The DC sources satisfy Criterion 3 of the NRC Policy Statement.

LCO

Two 125V vital DC electrical power subsystems (Train A and Train B), each vital subsystem consisting of two channels. Each channel consisting of a battery bank, associated battery charger and the corresponding control equipment and interconnecting cabling supplying power to the associated DC bus within the channel; and one DG DC electrical power system for each DG, consisting of a battery, a dual battery charger assembly, and the corresponding control equipment and interconnecting cabling are required to be OPERABLE to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence (A00) or a postulated DBA. Loss of any DC electrical power subsystem does not prevent the minimum safety function from being performed (Ref. 4).

An OPERABLE vital DC electrical power subsystem requires all required batteries and respective chargers to be operating and connected to the associated DC buses.

Each DG DC electrical power system is independent and dedicated to its respective DG. The DGs that are supported by the DG DC electrical power systems are arranged in redundant trains (i.e., DG 1A-A and DG 2A-A are in Train A, and DG 1B-B and DG 2B-B are in Train B). When one or two DGs in a train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Likewise, if one or two of the DG DC electrical power systems that support the DGs in that train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Therefore, the LCO requires two DG DC electrical power trains to be OPERABLE to support the redundancy of the standby electrical power system.

(continued)

BASES (continued)

LCO (continued)

The LCO is modified by a Note. The Note indicates that Vital Battery V may be substituted for any of the required vital batteries. However, the fifth battery cannot be declared OPERABLE until it is connected electrically in place of another battery and it has satisfied applicable Surveillance Requirements.

APPLICABILITY

The vital DC electrical power sources and DG DC electrical power sources are required to be OPERABLE in MODES 1, 2, 3, and 4 to ensure safe plant operation and to ensure that:

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOs or abnormal transients; and

b. Adequate core cooling is provided, and containment integrity and other vital functions are maintained in the event of a postulated DBA.

The DC electrical power requirements for MODES 5 and 6 are addressed in the Bases for LCO 3.8.5, "DC Sources - Shutdown."

ACTIONS

A.1, A.2, and A.3

Condition A represents one vital DC subsystem with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action A.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage. Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action A.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage

(continued)

BASES (continued)

ACTIONS

A.1, A.2, and A.3 (continued)

does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action A.2).

Required Action A.2 requires that the battery float current be verified as less than or equal to 2 amps. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 2 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 2 amps this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action A.3 limits the restoration time for the inoperable battery charger to 7 days. This action is applicable if an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage has been used (e.g., balance of plant non-Class 1E battery charger). The 7 day Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

B.1

Condition B represents one vital DC electrical power subsystem with a loss of ability to completely respond to an event, and a potential loss of ability to remain energized during normal operation. It is, therefore, imperative that the operator's attention focus on stabilizing the plant, minimizing the potential for complete loss of DC power to the affected subsystem. The 2 hour limit is consistent with the allowed time for an inoperable DC distribution subsystem.

If one of the required vital DC electrical power subsystems is inoperable for reasons other than Condition A (e.g., inoperable battery charger and associated inoperable battery), the remaining vital DC electrical power subsystem has the capacity to support a safe shutdown and to mitigate an accident condition. Since a subsequent worst case single failure of the OPERABLE subsystem could, however, result in the loss of the minimum necessary vital DC electrical power subsystems to mitigate a worst-case accident, continued power operation should not exceed 2 hours. The 2 hour Completion Time is based on Regulatory

(continued)

BASES (continued)

ACTIONS

B.1 (continued)

Guide 1.93 (Ref. 7) and reflects a reasonable time to assess plant status as a function of the inoperable vital DC electrical power subsystem and, if the vital DC electrical power subsystem is not restored to OPERABLE status, to prepare to effect an orderly and safe plant shutdown.

C,1 and C.2

If the inoperable vital DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The Completion Time to bring the plant to MODE 5 is consistent with the time required in Regulatory Guide 1.93 (Ref. 7).

D.1, D.2, and D.3

Condition D represents one DG DC train with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action D.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage.

Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage

(continued)

BASES (continued)

ACTIONS (continued)

D.1, D.2, and D.3 (continued)

does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DG DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2).

Required Action D.2 requires that the battery float current be verified as less than or equal to 1 amp. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 1 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 1 amp this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action D.3 limits the restoration time for the inoperable battery charger to 72 hours. The 72 hour Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

E.1

Condition E represents one DG with a loss of ability to completely respond to an event. Since a subsequent single failure on the opposite train could result in a situation where the required ESF function is not assured, continued power operation should not exceed 2 hours. The 2 hour time limit is consistent with the allowed time for an inoperable vital DC electrical power subsystem.

F.1

If the DG DC electrical power subsystem cannot be restored to OPERABLE status in the associated Completion Time, the associated DG may be incapable of performing its intended function and must be immediately declared inoperable. This declaration also requires entry into applicable Conditions and Required Actions for an inoperable DG, LCO 3.8.1, "AC Sources-Operating."

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BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1 and SR 3.8.4.2

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the battery chargers, which support the ability of the batteries to perform their intended function. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a fully charged state while supplying the continuous steady state loads of the associated DC subsystem. On float charge, battery cells will receive adequate current to optimally charge the battery. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the minimum float voltage established by the battery manufacturer (2.20 Vpc times the number of connected cells or 132 V at the battery terminals for a 60 cell vital battery; 127.6 V at the battery terminals for a 58 cell DG battery). This voltage maintains the battery plates in a condition that supports maintaining the grid life. The 7 day Frequency is consistent with manufacturer recommendations.

SR 3.8.4.3

Verifying that for the vital batteries that the alternate feeder breakers to each required battery charger is open ensures that independence between the power trains is maintained. The 7-day Frequency is based on engineering judgement, is consistent with procedural controls governing breaker operation, and ensures correct breaker position.

SR 3.8.4.4

This SR demonstrates that the DG 125V DC distribution panel and associated charger are functioning properly, with all required circuit breakers closed and buses energized from normal power. The 7 day Frequency takes into account the redundant DG capability and other indications available in the control room that will alert the operator to system malfunctions.

SR 3.8.4.5

This SR verifies the design capacity of the vital battery chargers. According to Regulatory Guide 1.32 (Ref. 5), the battery charger supply is recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. The minimum required amperes and duration ensure that these requirements can be satisfied.

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.5 (continued)

This SR provides two options. One option requires that each battery charger be capable of supplying 200 amps at the minimum established float voltage (132 V DC) for 4 hours. The ampere requirements are based on the output rating of the chargers. The voltage requirements are based on the charger voltage level after a response to a loss of AC power.

The other option requires that each vital battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 2 amps.

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

SR 3.8.4.6

This SR verifies the design capacity of the DG battery chargers. According to Regulatory Guide 1.32 (Ref. 5), the battery charger supply is recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. The minimum required amperes and duration ensure that these requirements can be satisfied.

This SR requires that each DG battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 1 amp.

The Surveillance Frequency is acceptable, given the administrative controls existing to ensure adequate charger performance during these 18 month intervals.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.6 (continued)

For the DG DC electrical subsystem, this Surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the DG DC electrical power subsystem supplies loads only for the inoperable diesel generator and would not otherwise challenge safety systems supplied from vital electrical distribution systems. If available, the C-S DG and its associated DC electrical power subsystem may be substituted in accordance with LCO Note 2. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

SR 3.8.4.7

A battery service test is a special test of battery capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The discharge rate and test length should correspond to worst case design duty cycle requirements based on References 8 and 10.

The Surveillance Frequency of 18 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. 5) and Regulatory Guide 1.129 (Ref. 9), which state that the battery service test should be performed during refueling operations or at some other outage, with intervals between tests, not to exceed 18 months.

This SR is modified by two Notes. Note 1 allows the performance of a modified performance discharge test in lieu of a service test.

The reason for Note 2 is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES l, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note l. For the DG DC electrical subsystem, this surveillance may be performed in MODES l, 2, 3, or 4 in conjunction with LCO 3.8.l.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. If available, the C-S DG and its associated DC electrical power subsystem may be substituted in accordance with LCO Note 2. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.7 (continued)

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, Appendix A, General Design Criterion 17, “Electric Power System.”

2. Regulatory Guide 1.6, “Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems,” U.S. Nuclear Regulatory Commission, March 10, 1971.

3. IEEE-308-1971, “IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,” Institute of Electrical and Electronic Engineers.

4. Watts Bar FSAR, Section 8.3.2, “DC Power System.”

5. Regulatory Guide 1.32, “Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants,” February 1977, U.S. Nuclear Regulatory Commission.

6. Watts Bar FSAR, Section 15, “Accident Analysis” and Section 6 “Engineered Safety Features.”

7. Regulatory Guide 1.93, “Availability of Electric Power Sources,” U.S. Nuclear Regulatory Commission, December 1974.

8. TVA Calculation WBN EEB-MS-TI11-0003, “125 VDC Vital Battery and Charger Evaluation.”

9. Regulatory Guide 1.129, “Maintenance Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Subsystems,” U.S. Nuclear Regulatory Commission, February 1978.

10. TVA Calculation WBN EEB-MS-TI11-0062, "125 V DC Diesel Generator Control Power System Evaluation."

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.6 Battery Parameters

BASES

BACKGROUND

This LCO delineates the limits on battery float current as well as electrolyte temperature, level, and float voltage for the 125V vital DC electrical power subsystem and diesel generator (DG) batteries. A discussion of these batteries and their OPERABILITY requirements is provided in the Bases for LCO 3.8.4, "DC Sources - Operating," and LCO 3.8.5, "DC Sources - Shutdown." In addition to the limitations of this Specification, the Battery Monitoring and Maintenance Program also implements a program specified in Specification 5.7.2.22 for monitoring various battery parameters.

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 3).

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 1) and Section 15 (Ref. 1), assume Engineered Safety Feature systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining at least one subsystem of DC sources OPERABLE during accident conditions, in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

Battery parameters satisfy the Criterion 3 of the NRC Policy Statement.

BASES

LCO

Battery parameters must remain within acceptable limits to ensure availability of the required DC power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. Battery parameter limits are conservatively established, allowing continued DC electrical system function even with limits not met. Additional preventative maintenance, testing, and monitoring performed in accordance with the Battery Monitoring and Maintenance Program is conducted as specified in Specification 5.7.2.22.

APPLICABILITY

The battery parameters are required solely for the support of the associated vital DC and DG DC electrical power subsystems. Therefore, battery parameter limits are only required when the DC power source is required to be OPERABLE. Refer to the Applicability discussion in Bases for LCO 3.8.4 and LCO 3.8.5.

ACTIONS

A.1, A.2, and A.3

With one or more cells in one or more batteries in one vital DC subsystem < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.1) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.1). This assures that there is still sufficient battery capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.1 or SR 3.8.6.1 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.1 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

B.1 and B.2

One or more batteries in one vital DC subsystem with float current > 2 amps indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition A

(continued)

ACTIONS

B.1 and B.2 (continued)

addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action B.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.4.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

C.1, C.2, and C.3

With one or more cells in one or more batteries in one DG DC train < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.2) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.2). This assures that there is still sufficient battery capacity to perform the intended function.

(continued)

BASES

ACTIONS

C.1, C.2, and C.3 (continued)

Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.2 or SR 3.8.6.2 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.2 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

D.1 and D.2

One or more batteries in one DG DC train with float current > 1 amp indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition B addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

(continued)

ACTIONS

D.1 and D.2 (continued)

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action D.1 only specifies "perform," a failure of SR 3.8.4.2 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.2 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

E.1, E.2, and E.3

With one or more required batteries in one vital DC subsystem or one or more DG batteries in one train with one or more cells electrolyte level above the top of the plates, but below the minimum established design limits, the battery still retains sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of electrolyte level not met. Within 31 days the minimum established design limits for electrolyte level must be re-established.

With electrolyte level below the top of the plates there is a potential for dryout and plate degradation. Required Actions E.1 and E.2 address this potential (as well as provisions in Specification 5.7.2.22, Battery Monitoring and Maintenance Program). They are modified by a Note that indicates they are only applicable if electrolyte level is below the top of the plates. Within 8 hours level is required to be restored to above the top of the plates. The Required Action E.2 requirement to verify that there is no leakage by visual inspection and the Specification 5.7.2.22.b item to initiate action to equalize and test in accordance with manufacturer's recommendation. They are performed following the restoration of the electrolyte level to above the top of the plates. Based on the results of the manufacturer's recommended testing the battery(ies) may have to be declared inoperable and the affected cell(s) replaced.

F.1

With one or more batteries in one vital DC subsystem or one or more DG batteries in one train with pilot cell temperature less than the minimum established design limits, 12 hours is allowed to restore the temperature to within limits. A low electrolyte temperature limits the current and power available. Since the battery is sized with margin, while battery capacity is degraded, sufficient capacity exists to perform the intended function and the affected battery is not required to be considered inoperable solely as a result of the pilot cell temperature not met.

(continued)

BASES

ACTIONS (continued)

G.1

With one or more vital batteries in redundant DC subsystems with battery parameters not within limits there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function, given that redundant batteries are involved. With redundant batteries involved this potential could result in a total loss of function on multiple systems that rely upon the batteries.

The longer Completion Times specified for vital battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one subsystem within 2 hours.

H.1

With one or more DG batteries in redundant DG trains with battery parameters not within limits, there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function. With batteries in redundant DG trains involved, this potential could result in a total loss of function for DGs that rely upon the batteries.

The longer Completion Times specified for battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one train within 2 hours.

I.1

With one or more batteries with any battery parameter outside the allowances of the Required Actions for Condition A, B, C, D, E, F, G, or H, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding battery must be declared inoperable. Additionally, discovering one or more vital DC batteries in one subsystem with one or more battery cells float voltage less than 2.07 V and float current greater than 2 amps, or one or more DG batteries in one train with one or more battery cells float voltage greater than or equal to 2.07 V and float current greater than 1 amp, indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1 and SR 3.8.6.2

Verifying battery float current while on float charge is used to determine the state of charge of the battery. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The equipment used to monitor float current must have the necessary accuracy and capability to measure electrical currents in the expected range. The float current requirements are based on the float current indicative of a charged battery. The 7 day Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.1 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION A are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 2 amps is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.2 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION D are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 1 amp is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.3 and SR 3.8.6.6

Optimal long term battery performance is obtained by maintaining a float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer, which corresponds to 132 V at the battery terminals, or 2.20 Vpc. This provides adequate overpotential, which limits the formation of lead sulfate and self discharge, which could eventually render the battery inoperable. Float voltages in this range or less, but greater than 2.07 Vpc, are addressed in Specification 5.7.2.22. SRs 3.8.6.3 and 3.8.6.6 require verification that the cell float voltages are equal to or greater than the short term absolute minimum voltage of 2.07 V. The Frequency for cell voltage verification every 31 days for pilot cell and 92 days for each connected cell is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.4

The limit specified for electrolyte level ensures that the plates suffer no physical damage and maintains adequate electron transfer capability. The minimum design electrolyte level is the minimum level indication mark on the battery cell jar. The Frequency is consistent with IEEE-450 (Ref. 2).

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.6.5

This Surveillance verifies that the pilot cell temperature is greater than or equal to the minimum established design limit (i.e., 60°F for the vital batteries and 50°F for the DG batteries). Pilot cell electrolyte temperature is maintained above this temperature to assure the battery can provide the required current and voltage to meet the design requirements. Temperatures lower than assumed in battery sizing calculations act to inhibit or reduce battery capacity. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.7

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.6.7; however, only the modified performance discharge test may be used to satisfy the battery service test requirements of SR 3.8.4.7.

A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle). This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

It may consist of just two rates; for instance the one minute rate for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test must remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 2) and IEEE-485 (Ref. 4). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer's rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements. Furthermore, the battery is sized to meet the assumed duty cycle loads when the battery design capacity reaches this 80% limit.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.6.7 (continued)

The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's ratings. Degradation is indicated, according to IEEE-450 (Ref. 2), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer's rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 2).

This SR is modified by a Note. The reason for the Note is that performing the Surveillance would perturb the electrical distribution system and challenge safety systems. Credit may be taken for unplanned events that satisfy this SR.

REFERENCES

1. Watts Bar FSAR, Section 15, "Accident Analysis," and Section 6, "Engineered Safety Features."
2. IEEE-450-2002, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications."
3. Watts Bar FSAR, Section 8, "Electric Power."
4. IEEE-485-1983, "IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations."

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources - Operating

LCO 3.8.4 The Train A and Train B vital DC and Diesel Generator (DG) DC electrical power subsystems shall be OPERABLE.

---NOTE--
Vital Battery V may be substituted for any of the required vital batteries.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery charger(s) on one subsystem inoperable.	A.1 Restore battery terminal voltage to greater than or equal to the minimum established float voltage.	2 hours
	AND	
	A.2 Verify battery float current ≤ 2 amps.	Once per 12 hours
	AND	
	A.3 Restore vital battery charger(s) to OPERABLE status.	7 days
B. One vital DC electrical power subsystem inoperable for reasons other than Condition A.	B.1 Restore vital DC electrical power subsystem to OPERABLE status.	2 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. Required Action and Associated Completion Time of Condition A or B not met.	C.1 Be in MODE 3. <u>AND</u> C.2 Be in MODE 5.	6 hours 36 hours
D. One or two DG DC battery charger(s) on one train inoperable.	D.1 Restore DG battery terminal voltage to greater than or equal to the minimum established float voltage. <u>AND</u> D.2 Verify battery float current ≤ 1 amp. <u>AND</u> D.3 Restore DG battery charger(s) to OPERABLE status.	2 hours Once per 12 hours 72 hours
E. One DG DC train inoperable for reasons other than Condition D.	E.1 Restore DG DC train to OPERABLE status.	2 hours
F. Required Action and associated Completion Time of Condition D or E not met.	F.1 Declare associated DG inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify vital battery terminal voltage is greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.2	Verify DG battery terminal voltage is greater than or equal to the minimum established float voltage.	7 days
SR 3.8.4.3	Verify for the vital batteries that the alternate feeder breakers to each required battery charger are open.	7 days
SR 3.8.4.4	Verify correct breaker alignment and indicated power availability for each DG 125 V DC distribution panel and associated battery charger	7 days
SR 3.8.4.5	Verify each vital battery charger supplies ≥ 200 amps at greater than or equal to the minimum established float voltage for ≥ 4 hours. <u>OR</u> Verify each vital battery charger can recharge the battery to the fully charged state within 36 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months
SR 3.8.4.6	------------------------------NOTE----------------------------- Credit may be taken for unplanned events that satisfy this SR. --- Verify each DG battery charger can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	18 months

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.7	-------------------------------NOTES---------------------------- 1. The modified performance discharge test in SR 3.8.6.7 may be performed in lieu of the service test in SR 3.8.4.7. 2. This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. ---	
	Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads and any connected nonsafety loads for the design duty cycle when subjected to a battery service test.	18 months

3.8 ELECTRICAL POWER SYSTEMS

3.8.6 Battery Parameters

LCO 3.8.6 Battery parameters for Train A and Train B electrical power subsystem 125 V vital batteries and 125 V diesel generator (DG) batteries shall be within limits.

APPLICABILITY: When associated DC electrical power subsystems and DGs are required to be OPERABLE.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each battery bank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V.	A.1 Perform SR 3.8.4.1. AND A.2 Perform SR 3.8.6.1. AND A.3 Restore affected cell voltage ≥ 2.07 V.	2 hours 2 hours 24 hours
B. One or two required vital battery(ies) on one subsystem with float current > 2 amps.	B.1 Perform SR 3.8.4.1. AND B.2 Restore vital battery float current to ≤ 2 amps.	2 hours 12 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V.	C.1 Perform SR 3.8.4.2. AND	2 hours
	C.2 Perform SR 3.8.6.2. AND	2 hours
	C.3 Restore affected cell voltage ≥ 2.07 V.	24 hours
D. One or two DG battery(ies) on one train with float current > 1 amp.	D.1 Perform SR 3.8.4.2. AND	2 hours
	D.2 Restore DG battery float current to ≤ 1 amp.	12 hours
----------------NOTE------------------- Required Action E.2 shall be completed if electrolyte level was below the top of plates. ---	------------------NOTE------------------- Required Actions E.1 and E.2 are only applicable if electrolyte level was below the top of plates. --	
E. One or two required vital battery(ies) on one subsystem with one or more cells electrolyte level less than minimum established design limits. OR One or two DG battery(ies) on one train with one or more cells electrolyte level less than minimum established design limits.	E.1 Restore electrolyte level to above top of plates. AND	8 hours
	E.2 Verify no evidence of leakage. AND	12 hours
	E.3 Restore electrolyte level to greater than or equal to minimum established design limits.	31 days

(continued)

ACTIONS (continued)

CONDITION		REQUIRED ACTION		COMPLETION TIME
F.	One or two required vital battery(ies) on one subsystem with pilot cell electrolyte temperature less than minimum established design limits. <u>OR</u> One or two DG battery(ies) on one train with pilot cell electrolyte temperature less than minimum established design limits.	F.1	Restore battery pilot cell temperature to greater than or equal to minimum established design limits.	12 hours
G.	One or more vital batteries in redundant subsystems with battery parameters not within limits.	G.1	Restore battery parameters for vital batteries in one subsystem to within limits.	2 hours
H.	One or more DG batteries in redundant trains with battery parameters not within limits.	H.1	Restore battery parameters for DG batteries in one train to within limits.	2 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
I. Required Action and associated Completion Time of Condition A, B, C, D, E, F, G, or H not met. <u>OR</u> One or two required vital battery(ies) on one subsystem with one or more battery cells float voltage < 2.07 V and float current > 2 amps. <u>OR</u> One or two DG battery(ies) on one train with one or more battery cells float voltage < 2.07 V and float current > 1 amp.	I.1 Declare associated battery inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	---------------------------NOTE----------------------------- Not required to be met when vital battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. --- Verify each vital battery float current is ≤ 2 amps.	7 days
SR 3.8.6.2	---------------------------NOTE----------------------------- Not required to be met when DG battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. --- Verify each DG battery float current is ≤ 1 amp.	7 days
SR 3.8.6.3	Verify each required vital battery and each DG battery pilot cell float voltage is ≥ 2.07 V.	31 days
SR 3.8.6.4	Verify each required vital battery and each DG battery connected cell electrolyte level is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.5	Verify each required vital battery and each DG battery pilot cell temperature is greater than or equal to minimum established design limits.	31 days
SR 3.8.6.6	Verify each required vital battery and each DG battery connected cell float voltage is ≥ 2.07 V.	92 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.6.7	---------------------------NOTES-------------------------- This Surveillance is not performed in MODE 1, 2, 3, or 4 for required vital batteries. Credit may be taken for unplanned events that satisfy this SR. --- Verify battery capacity is ≥ 80% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.	60 months <u>AND</u> 12 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating <u>AND</u> 24 months when battery has reached 85% of the expected life with capacity ≥ 100% of manufacturer's rating

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.4 DC Sources - Operating

BASES

BACKGROUND

The station DC electrical power system provides the AC emergency power system with control power. It also provides both motive and control power to selected safety related equipment and preferred AC vital bus power (via inverters). As required by 10 CFR 50, Appendix A, GDC 17 (Ref. 1), the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. The DC electrical power system also conforms to the recommendations of Regulatory Guide 1.6 (Ref. 2) and IEEE-308 (Ref. 3).

<u>125 V Vital DC Electrical Power Subsystem</u>

The vital 125 VDC electrical power system is a Class 1E system whose safety function is to provide control power for engineered safety features equipment, emergency lighting, vital inverters, and other safety related DC powered equipment for the entire unit. The system capacity is sufficient to supply these loads and any connected non-safety loads during normal operation and to permit safe shutdown and isolation of the reactor for the “loss of all AC power” condition. The system is designed to perform its safety function subject to a single failure.

The 125V DC vital power system is composed of the four channels (Channels I and III are associated with Train A and Channels II and IV are associated with Train B) and consists of four lead-acid-calcium batteries, eight battery chargers (including two pairs of spare chargers), four distribution boards, battery racks, and the required cabling, instrumentation and protective features. Each channel is electrically and physically independent from the equipment of all other channels so that a single failure in one channel will not cause a failure in another channel. Each channel consists of a battery charger which supplies normal DC power, a battery for emergency DC power, and a battery board which facilitates load grouping and provides circuit protection. These four channels are used to provide emergency power to the 120V AC vital power system which furnishes control power to the reactor protection system. No automatic connections are used between the four channels.

Battery boards I, II, III, and IV have a charger normally connected to them and also have manual access to a spare (backup) charger for use upon loss of the normal charger.

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

Additionally, battery boards I, II, III, and IV have manual access to the fifth vital battery system. The fifth 125V DC Vital Battery System is intended to serve as a replacement for any one of the four 125V DC vital batteries during their testing, maintenance, and outages with no loss of system reliability under any mode of operation.

Each of the vital DC electrical power subsystems provides the control power for its associated Class 1E AC power load group, 6.9 kV switchgear, and 480 V load centers. The vital DC electrical power subsystems also provide DC electrical power to the inverters, which in turn power the AC vital buses. Additionally, they power the emergency DC lighting system.

The vital DC power distribution system is described in more detail in Bases for LCO 3.8.9, "Distribution System - Operating," and LCO 3.8.10, "Distribution Systems - Shutdown."

Each 125 VDC vital battery is separately housed in a ventilated room apart from its charger and distribution centers, except for Vital Battery V. Each subsystem is located in an area separated physically and electrically from the other subsystem to ensure that a single failure in one subsystem does not cause a failure in a redundant subsystem. There is no sharing between Class 1E subsystems, such as batteries, battery chargers, or distribution panels.

Each battery has adequate storage capacity to meet the duty cycle(s) discussed in the FSAR, Chapter 8 (Ref 4). The battery is designed with additional capacity above that required by the design duty cycle to allow for temperature variations and other factors.

The batteries for the vital DC electrical power subsystems are sized to produce required capacity at 80% of nameplate rating, corresponding to warranted capacity at end of life cycles, and the 100% design demand. The minimum design voltage limit is 105 V.

(continued)

BASES

BACKGROUND

125 V Vital DC Electrical Power Subsystem (continued)

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for a 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 4).

Each Vital DC electrical power subsystem battery charger has ample power output capacity for the steady state operation of connected loads required during normal operation, while at the same time maintaining its battery bank fully charged. Each battery charger also has sufficient excess capacity to restore the battery bank from the design minimum charge to its fully charged state within 12 hours (with accident loads being supplied) following a 30 minute AC power outage and in approximately 36 hours (while supplying normal steady state loads following a 2 hour AC power outage), (Ref. 5).

The battery charger is normally in the float-charge mode. Float-charge is the condition in which the charger is supplying the connected loads and the battery cells are receiving adequate current to optimally charge the battery. This assures the internal losses of a battery are overcome and the battery is maintained in a fully charged state.

When desired, the charger can be placed in the equalize mode. The equalize mode is at a higher voltage than the float mode and charging current is correspondingly higher. The battery charger is operated in the equalize mode after a battery discharge or for routine maintenance. Following a battery discharge, the battery recharge characteristic accepts current at the current limit of the battery charger (if the discharge was significant, e.g., following a battery service test) until the battery terminal voltage approaches the charger voltage setpoint. Charging current then reduces exponentially during the remainder of the recharge cycle. Lead-calcium batteries have recharge efficiencies of greater than 95%, so once at least 105% of the ampere-hours discharged have been returned, the battery capacity would be restored to the same condition as it was prior to the discharge. This can be monitored by direct observation of the exponentially decaying charging current or by evaluating the amp-hours discharged from the battery and amp-hours returned to the battery.

BASES

BACKGROUND (continued)

125 V Diesel Generator (DG) DC Electrical Power Subsystem

Control power for the DGs is provided by four DG battery systems, one per DG. Each system is comprised of a battery, a battery charger, distribution center, cabling, and cable ways. The DG 125V DC control power and field-flash circuits have power supplied from their respective 125V distribution panel. The normal supply of DC current is from the associated charger. The battery provides control and field-flash power when the charger is unavailable. The charger supplies the normal DC loads, maintains the battery in a fully charged condition, and recharges (480V AC available) the battery while supplying the required loads regardless of the status of the unit. The batteries are physically and electrically independent. The battery has sufficient capacity when fully charged to supply required loads for a minimum of four hours following a loss of normal power. Each battery is normally required to supply loads during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from its respective DG.

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 6), and in the FSAR, Section 15 (Ref. 6), assume that Engineered Safety Feature (ESF) systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining the DC sources OPERABLE during accident conditions in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

The DC sources satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

BASES (continued)

LCO

Two 125V vital DC electrical power subsystems (Train A and Train B), each vital subsystem consisting of two channels. Each channel consisting of a battery bank, associated battery charger and the corresponding control equipment and interconnecting cabling supplying power to the associated DC bus within the channel; and one DG DC electrical power system for each DG, consisting of a battery, a dual battery charger assembly, and the corresponding control equipment and interconnecting cabling are required to be OPERABLE to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence (A00) or a postulated DBA. Loss of any DC electrical power subsystem does not prevent the minimum safety function from being performed (Ref. 4).

An OPERABLE vital DC electrical power subsystem requires all required batteries and respective chargers to be operating and connected to the associated DC buses.

Each DG DC electrical power system is independent and dedicated to its respective DG. The DGs that are supported by the DG DC electrical power systems are arranged in redundant trains (i.e., DG 1A-A and DG 2A-A are in Train A, and DG 1B-B and DG 2B-B are in Train B). When one or two DGs in a train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Likewise, if one or two of the DG DC electrical power systems that support the DGs in that train are inoperable, that train is incapable of performing the safety function and must rely on the redundant train to mitigate an event. Therefore, the LCO requires two DG DC electrical power trains to be OPERABLE to support the redundancy of the standby electrical power system.

The LCO is modified by one Note. The Note indicates that Vital Battery V may be substituted for any of the required vital batteries. However, the fifth battery cannot be declared OPERABLE until it is connected electrically in place of another battery and it has satisfied applicable Surveillance Requirements.

APPLICABILITY

The vital DC electrical power sources and DG DC electrical power sources are required to be OPERABLE in MODES 1, 2, 3, and 4 to ensure safe plant operation and to ensure that:

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOs or abnormal transients; and

b. Adequate core cooling is provided, and containment integrity and other vital functions are maintained in the event of a postulated DBA.

The DC electrical power requirements for MODES 5 and 6 are addressed in the Bases for LCO 3.8.5, “DC Sources - Shutdown.”

BASES (continued)

ACTIONS

A.1, A.2, and A.3

Condition A represents one vital DC subsystem with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action A.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage. Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action A.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DC system is designed for.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action A.2).

Required Action A.2 requires that the battery float current be verified as less than or equal to 2 amps. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement.

(continued)

BASES (continued)

ACTIONS

A.1, A.2, and A.3 (continued)

The 2 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 2 amps this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action A.3 limits the restoration time for the inoperable battery charger to 7 days. This action is applicable if an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage has been used (e.g., balance of plant non-Class 1E battery charger). The 7 day Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

B.1

Condition B represents one vital DC electrical power subsystem with a loss of ability to completely respond to an event, and a potential loss of ability to remain energized during normal operation. It is, therefore, imperative that the operator's attention focus on stabilizing the plant, minimizing the potential for complete loss of DC power to the affected subsystem. The 2 hour limit is consistent with the allowed time for an inoperable DC distribution subsystem.

If one of the required vital DC electrical power subsystems is inoperable for reasons other than Condition A (e.g., inoperable battery charger and associated inoperable battery), the remaining vital DC electrical power subsystem has the capacity to support a safe shutdown and to mitigate an accident condition. Since a subsequent worst case single failure of the OPERABLE subsystem could, however, result in the loss of the minimum necessary vital DC electrical power subsystems to mitigate a worst-case accident, continued power operation should not exceed 2 hours. The 2 hour Completion Time is based on Regulatory Guide 1.93 (Ref. 7) and reflects a reasonable time to assess plant status as a function of the inoperable vital DC electrical power subsystem and, if the vital DC electrical power subsystem is not restored to OPERABLE status, to prepare to effect an orderly and safe plant shutdown.

(continued)

BASES

ACTIONS (continued)

C.1 and C.2

If the inoperable vital DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The Completion Time to bring the plant to MODE 5 is consistent with the time required in Regulatory Guide 1.93 (Ref. 7).

D.1, D.2, and D.3

Condition D represents one DG DC train with one or two battery chargers inoperable (e.g., the voltage limit of SR 3.8.4.1 is not maintained). The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action D.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage.

Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to the charger inoperability.

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DG DC system is designed for.

BASES

ACTIONS

D.1, D.2, and D.3 (continued)

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2).

Required Action D.2 requires that the battery float current be verified as less than or equal to 1 amp. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it is now fully capable of supplying the maximum expected load requirement. The 1 amp value is based on returning the battery to 98% charge and assumes a 2% design margin for the battery. If at the expiration of the initial 12 hour period the battery float current is not less than or equal to 1 amp this indicates there may be additional battery problems and the battery must be declared inoperable.

Required Action D.3 limits the restoration time for the inoperable battery charger to 72 hours. The 72 hour Completion Time reflects a reasonable time to effect restoration of the qualified battery charger to OPERABLE status.

E.1

Condition E represents one DG with a loss of ability to completely respond to an event. Since a subsequent single failure on the opposite train could result in a situation where the required ESF function is not assured, continued power operation should not exceed 2 hours. The 2 hour time limit is consistent with the allowed time for an inoperable vital DC electrical power subsystem.

F.1

If the DG DC electrical power subsystem cannot be restored to OPERABLE status in the associated Completion Time, the associated DG may be incapable of performing its intended function and must be immediately declared inoperable. This declaration also requires entry into applicable Conditions and Required Actions for an inoperable DG, LCO 3.8.1, "AC Sources-Operating."

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1 and SR 3.8.4.2

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the battery chargers, which support the ability of the batteries to perform their intended function. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a fully charged state while supplying the continuous steady state loads of the associated DC subsystem. On float charge, battery cells will receive adequate current to optimally charge the battery. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the minimum float voltage established by the battery manufacturer (2.20 Vpc times the number of connected cells or 132 V at the battery terminals for a 60 cell vital battery; 127.6 V at the battery terminals for a 58 cell DG battery). This voltage maintains the battery plates in a condition that supports maintaining the grid life. The 7 day Frequency is consistent with manufacturer recommendations.

SR 3.8.4.3

Verifying that for the vital batteries that the alternate feeder breakers to each required battery charger is open ensures that independence between the power trains is maintained. The 7 day Frequency is based on engineering judgment, is consistent with procedural controls governing breaker operation, and ensures correct breaker position.

SR 3.8.4.4

This SR demonstrates that the DG 125V DC distribution panel and associated charger are functioning properly, with all required circuit breakers closed and buses energized from normal power. The 7 day Frequency takes into account the redundant DG capability and other indications available in the control room that will alert the operator to system malfunctions.

(continued)

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.4.5

This SR verifies the design capacity of the vital battery chargers. According to Regulatory Guide 1.32 (Ref. 5), the battery charger supply is recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. The minimum required amperes and duration ensure that these requirements can be satisfied.

This SR provides two options. One option requires that each battery charger be capable of supplying 200 amps at the minimum established float voltage (132 V DC) for 4 hours. The ampere requirements are based on the output rating of the chargers. The voltage requirements are based on the charger voltage level after a response to a loss of AC power.

The other option requires that each vital battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 2 amps.

The Surveillance Frequency is acceptable, given the plant conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 18 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.6

This SR verifies the design capacity of the DG battery chargers. According to Regulatory Guide 1.32 (Ref. 5), the battery charger supply is recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during these demand occurrences. The minimum required amperes and duration ensure that these requirements can be satisfied.

This SR requires that each DG battery charger be capable of recharging the battery after a service test coincident with supplying the largest coincident demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur).

This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the measured charging current is ≤ 1 amp.

The Surveillance Frequency is acceptable, given the administrative controls existing to ensure adequate charger performance during these 18 month intervals.

For the DG DC electrical subsystem, this Surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the DG DC electrical power subsystem supplies loads only for the inoperable diesel generator and would not otherwise challenge safety systems supplied from vital electrical distribution systems. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.8.4.7

A battery service test is a special test of battery capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The discharge rate and test length should correspond to worst case design duty cycle requirements based on References 8 and 10.

The Surveillance Frequency of 18 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. 5) and Regulatory Guide 1.129 (Ref. 9), which state that the battery service test should be performed during refueling operations or at some other outage, with intervals between tests, not to exceed 18 months.

This SR is modified by two Notes. Note 1 allows the performance of a modified performance discharge test in lieu of a service test.

The reason for Note 2 is that performing the Surveillance may perturb the vital electrical distribution system and challenge safety systems. However, this Surveillance may be performed in MODES 1, 2, 3, or 4 provided that Vital Battery V is substituted in accordance with LCO Note 1. For the DG DC electrical subsystem, this surveillance may be performed in MODES 1, 2, 3, or 4 in conjunction with LCO 3.8.1.B since the supplied loads are only for the inoperable diesel generator and would not otherwise challenge safety system loads which are supplied from vital electrical distribution systems. Additionally, credit may be taken for unplanned events that satisfy this SR. Examples of unplanned events may include:

1) Unexpected operational events which cause the equipment to perform the function specified by this Surveillance, for which adequate documentation of the required performance is available; and

2) Post corrective maintenance testing that requires performance of this Surveillance in order to restore the component to OPERABLE, provided the maintenance was required, or performed in conjunction with maintenance required to maintain OPERABILITY or reliability.

(continued)

BASES

REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, Appendix A, General Design Criterion 17, "Electric Power System."

2. Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," U.S. Nuclear Regulatory Commission, March 10, 1971.

3. IEEE-308-1971, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," Institute of Electrical and Electronic Engineers.

4. Watts Bar FSAR, Section 8.3.2, "DC Power System."

5. Regulatory Guide 1.32, "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants," February 1977, U.S. Nuclear Regulatory Commission.

6. Watts Bar FSAR, Section 15, "Accident Analysis" and Section 6 "Engineered Safety Features."

7. Regulatory Guide 1.93, "Availability of Electric Power Sources," U.S. Nuclear Regulatory Commission, December 1974.

8. TVA Calculation EDQ00023620070003, "125V DC Vital Battery System Analysis"

9. Regulatory Guide 1.129, "Maintenance Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Subsystems," U.S. Nuclear Regulatory Commission, February 1978.

10. TVA Calculation WBN EEB-EDQ00023620070003, "125V DC Vital Battery System Analysis."

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.6 Battery Parameters

BASES

BACKGROUND

This LCO delineates the limits on battery float current, electrolyte temperature, electrolyte level, and float voltage for the 125V vital DC electrical power subsystem and the diesel generator (DG) batteries. A discussion of these batteries and their OPERABILITY requirements is provided in the Bases for LCO 3.8.4, “DC Sources - Operating,” and LCO 3.8.5, “DC Sources - Shutdown.” In addition to the limitations of this Specification, the Battery Monitoring and Maintenance Program also implements a program specified in Specification 5.7.2.22 for monitoring various battery parameters.

The battery cells are of flooded lead acid construction with a nominal specific gravity of 1.215. This specific gravity corresponds to an open circuit battery voltage of approximately 120 V for 60 cell battery (i.e., cell voltage of 2.063 volts per cell (Vpc)). The open circuit voltage is the voltage maintained when there is no charging or discharging. Optimal long term performance however, is obtained by maintaining a float voltage 2.20 to 2.25 Vpc. This provides adequate over-potential which limits the formation of lead sulfate and self discharge. The nominal float voltage of 2.22 Vpc corresponds to a total float voltage output of 133.2 V for a 60 cell battery as discussed in the FSAR, Chapter 8 (Ref. 3).

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the FSAR, Section 6 (Ref. 1) and Section 15 (Ref. 1), assume Engineered Safety Feature systems are OPERABLE. The vital DC electrical power system provides normal and emergency DC electrical power for the emergency auxiliaries, and control and switching during all MODES of operation. The DG battery systems provide DC power for the DGs.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the plant. This includes maintaining at least one subsystem of DC sources OPERABLE during accident conditions, in the event of:

a. An assumed loss of all offsite AC power or all onsite AC power; and

b. A worst case single failure.

Battery parameters satisfy the Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

Battery parameters must remain within acceptable limits to ensure availability of the required DC power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. Battery parameter limits are conservatively established, allowing continued DC electrical system function even with limits not met. Additional preventative maintenance, testing, and monitoring performed in accordance with the Battery Monitoring and Maintenance Program is conducted as specified in Specification 5.7.2.22.

APPLICABILITY

The battery parameters are required solely for the support of the associated vital DC and DG DC electrical power subsystems. Therefore, battery parameter limits are only required when the DC power source is required to be OPERABLE. Refer to the Applicability discussion in Bases for LCO 3.8.4 and LCO 3.8.5.

ACTIONS

A.1, A.2, and A.3

With one or more cells in one or more batteries in one vital DC subsystem < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.1) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.1). This assures that there is still sufficient battery capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.1 or SR 3.8.6.1 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.1 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

B.1 and B.2

One or more batteries in one vital DC subsystem with float current > 2 amps indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition A addresses charger inoperability. If the charger is operating in the current

(continued)

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B.1 and B.2 (continued)

limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action B.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.4.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

C.1, C.2, and C.3

With one or more cells in one or more batteries in one DG DC train < 2.07 V, the battery cell is degraded. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.4.2) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.6.2). This assures that there is still sufficient battery capacity to perform the intended function.

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BASES

ACTIONS

C.1, C.2, and C.3 (continued)

Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < 2.07 V, and continued operation is permitted for a limited period up to 24 hours.

Since the Required Actions only specify "perform," a failure of SR 3.8.4.2 or SR 3.8.6.2 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.6.2 is failed then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

D.1 and D.2

One or more batteries in one DG DC train with float current > 1 amp indicates that a partial discharge of the battery capacity has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. Condition B addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 12 hours (Required Action D.2). The battery must therefore be declared inoperable.

If the float voltage is found to be satisfactory but there are one or more battery cells with float voltage less than 2.07 V, the associated "OR" statement in Condition I is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than 2.07 V there is good assurance that, within 12 hours, the battery will be restored to its fully charged condition (Required Action D.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery

(continued)

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D.1 and D.2 (continued)

to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus there is good assurance of fully recharging the battery within 12 hours, avoiding a premature shutdown with its own attendant risk.

If the condition is due to one or more cells in a low voltage condition but still greater than 2.07 V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 12 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action D.1 only specifies "perform," a failure of SR 3.8.4.2 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.4.2 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

E.1, E.2, and E.3

With one or more required batteries in one vital DC subsystem or one or more DG batteries in one train with one or more cells electrolyte level above the top of the plates, but below the minimum established design limits, the battery still retains sufficient capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of electrolyte level not met. Within 31 days the minimum established design limits for electrolyte level must be re-established.

With electrolyte level below the top of the plates there is a potential for dryout and plate degradation. Required Actions E.1 and E.2 address this potential (as well as provisions in Specification 5.7.2.22, Battery Monitoring and Maintenance Program). They are modified by a Note that indicates they are only applicable if electrolyte level is below the top of the plates. Within 8 hours level is required to be restored to above the top of the plates. The Required Action E.2 requirement to verify that there is no leakage by visual inspection and the Specification 5.7.2.22.b item to initiate action to equalize and test in accordance with manufacturer's recommendation. They are performed following the restoration of the electrolyte level to above the top of the plates. Based on the results of the manufacturer's recommended testing the battery(ies) may have to be declared inoperable and the affected cell(s) replaced.

F.1

With one or more batteries in one vital DC subsystem or one or more DG batteries in one train with pilot cell temperature less than the minimum established design limits, 12 hours is allowed to restore the

(continued)

ACTIONS (continued)

F.1 (continued)

temperature to within limits. A low electrolyte temperature limits the current and power available. Since the battery is sized with margin, while battery capacity is degraded, sufficient capacity exists to perform the intended function and the affected battery is not required to be considered inoperable solely as a result of the pilot cell temperature not met.

G.1

With one or more vital batteries in redundant DC subsystems with battery parameters not within limits there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function, given that redundant batteries are involved. With redundant batteries involved this potential could result in a total loss of function on multiple systems that rely upon the batteries.

The longer Completion Times specified for vital battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one subsystem within 2 hours.

H.1

With one or more DG batteries in redundant DG trains with battery parameters not within limits, there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function. With batteries in redundant DG trains involved, this potential could result in a total loss of function for DGs that rely upon the batteries.

The longer Completion Times specified for battery parameters on non-redundant batteries not within limits are therefore not appropriate, and the parameters must be restored to within limits on at least one train within 2 hours.

I.1

With one or more batteries with any battery parameter outside the allowances of the Required Actions for Condition A, B, C, D, E, F, G, or H, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding battery must be declared inoperable. Additionally, discovering one or more vital DC batteries in one subsystem with one or more battery cells float voltage less than 2.07 V and float current greater than 2 amps, or one or more DG batteries in one train with one or more battery cells float voltage greater than or equal to 2.07 V and float current greater than 1 amp, indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1 and SR 3.8.6.2

Verifying battery float current while on float charge is used to determine the state of charge of the battery. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The equipment used to monitor float current must have the necessary accuracy and capability to measure electrical currents in the expected range. The float current requirements are based on the float current indicative of a charged battery. The 7 day Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.1 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.1. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION A are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 2 amps is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.2 is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.4.2. When this float voltage is not maintained the Required Actions of LCO 3.8.4 ACTION D are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit of 1 amp is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

SR 3.8.6.3 and SR 3.8.6.6

Optimal long term battery performance is obtained by maintaining a float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer, which corresponds to 132 V at the battery terminals, or 2.20 Vpc. This provides adequate overpotential, which limits the formation of lead sulfate and self discharge, which could eventually render the battery inoperable. Float voltages in this range or less, but greater than 2.07 Vpc, are addressed in Specification 5.7.2.22. SRs 3.8.6.3 and 3.8.6.6 require verification that the cell float voltages are equal to or greater than the short term absolute minimum voltage of 2.07 V. The Frequency for cell voltage verification every 31 days for pilot cell and 92 days for each connected cell is consistent with IEEE-450 (Ref. 2).

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SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.6.4

The limit specified for electrolyte level ensures that the plates suffer no physical damage and maintains adequate electron transfer capability. The minimum design electrolyte level is the minimum level indication mark on the battery cell jar. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.5

This Surveillance verifies that the pilot cell temperature is greater than or equal to the minimum established design limit (i.e., 60°F for vital batteries and 50°F for DG batteries). Pilot cell electrolyte temperature is maintained above this temperature to assure the battery can provide the required current and voltage to meet the design requirements. Temperatures lower than assumed in battery sizing calculations act to inhibit or reduce battery capacity. The Frequency is consistent with IEEE-450 (Ref. 2).

SR 3.8.6.7

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.6.7; however, only the modified performance discharge test may be used to satisfy the battery service test requirements of SR 3.8.4.7.

A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle). This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

It may consist of just two rates; for instance the one minute rate for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test must remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.

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SURVEILLANCE REQUIREMENTS

SR 3.8.6.7 (continued)

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 2) and IEEE-485 (Ref. 4). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer's rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements. Furthermore, the battery is sized to meet the assumed duty cycle loads when the battery design capacity reaches this 80% limit.

The Surveillance Frequency for this test is normally 60 months. If the battery shows degradation, or if the battery has reached 85% of its expected life and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's ratings. Degradation is indicated, according to IEEE-450 (Ref. 2), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is ≥ 10% below the manufacturer's rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 2).

This SR is modified by a Note. The reason for the Note is that performing the Surveillance would perturb the electrical distribution system and challenge safety systems. Credit may be taken for unplanned events that satisfy this SR.

REFERENCES

1. Watts Bar FSAR, Section 15, “Accident Analysis,” and Section 6, “Engineered Safety Features.”
2. IEEE-450-2002, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications."
3. Watts Bar FSAR, Section 8, “Electric Power.”
4. IEEE-485-1983, "IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations."

Enclosure 4

Revised Regulatory Commitment

Commitment	Due Date/Event
TVA commits that the licensee-controlled program, required and described in TS Section 5.7, “Procedures, Programs, and Manuals,” and titled, “Battery Monitoring and Maintenance Program,” will require verification of the selection of the pilot cell or cells when performing SR 3.8.6.6.	Prior to implementation of the approved TSTF-500 license amendment