Duke Power.
A Duke Energy Company

D.M. JAMIL
Vice President

Duke Power
Catawba Nuclear Station
4800 Concord Rd. / CN01VP
York, SC 29745-9635

803 831 4251
803 831 3221 fax

April 6, 2004

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

Subject: Duke Energy Corporation
Catawba Nuclear Station (CNS), Units 1 and 2
Docket Numbers 50-413 and 50-414
Proposed Technical Specifications (TS) Amendments to Sections 3.8.4, "DC Sources - Operating"; 3.8.5 - "DC Sources - Shutdown"; and 3.8.6, "Battery Cell Parameters" and Associated TS Bases

Pursuant to 10 CFR 50.90, Duke is requesting amendments to Technical Specifications (TS) Sections 3.8.4, "DC Sources - Operating"; 3.8.5 - "DC Sources - Shutdown"; and 3.8.6, "Battery Cell Parameters" and associated TS Bases. This amendment change will allow a Diesel Generator (DG) Battery to remain operable with no more than one cell less than 1.36 Volts DC (Vdc) on float charge.

These license amendment requests have been developed based on information obtained via the battery manufacturer's report which includes a technical justification, battery sizing calculations, and supporting documentation. All calculations in the report were done in accordance with IEEE Standard 1115-2000, "IEEE Recommended Practice for Sizing Nickel Cadmium Batteries for Stationary Applications".

Duke is requesting that the NRC review and approve the enclosed license amendment requests no later than September 2004 to more accurately reflect the actual impact of a single battery cell failure on the actual diesel generator operability. This revision will also minimize unnecessary entries into a TS action statement due to an overly conservative TS requirement. The reprinted pages will be provided to the NRC following the completion of the technical review of the proposed amendment.

Implementation of this amendment will require revising Section 18, "Aging Management Programs and Activities" of the Catawba

A001

Safety Analysis Report (UFSAR) to reflect renumbered surveillance steps.

Duke Energy Corporation has determined that a 60-day implementation period would be preferred in order to revise surveillances with minimum impact on scheduling.

In accordance with Duke administrative procedures and the Quality Assurance Program Topical Report, the proposed amendment has been previously reviewed and approved by the CNS Plant Operations Review Committee and on an overall basis by the Duke Nuclear Safety Review Board.

The contents of this amendment request package are as follows:

1. Attachment 1 provides marked copies of the affected TS and TS Bases pages for Catawba showing the proposed changes.

2. Attachment 2 provides a description of the proposed changes and technical justification.

3. Pursuant to 10 CFR 50.92, Attachment 3 documents the determination that the amendments contain No Significant Hazards Considerations.

4. Pursuant to 10 CFR 51.22(c)(9), Attachment 4 provides the basis for the categorical exclusion from performing an Environmental Assessment/Impact Statement.

5. Attachment 5 contains the Manufacturer's Technical Justification, Battery Sizing Calculations, and Supporting Documentation.

Pursuant to 10 CFR 50.91, copies of these proposed amendments are being sent to the appropriate state officials.

There are no regulatory commitments contained in this letter or its attachments.

Inquiries on this matter should be directed to A.P Jackson at (803) 831-3742.

Very truly yours,

Dhiaa M. Jamil
Site Vice President
Catawba Nuclear Station

APJ/apj

Attachments

Dhiaa M. Jamil affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

Dhiaa M. Jamil, Site Vice President, Catawba Nuclear Station

Subscribed and sworn to me: 4-6-2004
Date

Micky Standridge
Notary Public

My commission expires: 7-10-2012
Date

SEAL

xc (with attachments):

L.A. Reyes
U.S. Nuclear Regulatory Commission
Regional Administrator, Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, GA 30303

E.F. Guthrie
Senior Resident Inspector (CNS)
U.S. Nuclear Regulatory Commission
Catawba Nuclear Station

S. E. Peters
NRC Project Manager (CNS)
U. S. Nuclear Regulatory Commission
Mail Stop O-8 G9
Washington, DC 20555-0001

H. J. Porter, Director
Division of Radioactive Waste Management
Bureau of Land and Waste Management
Department of Health and Environmental Control
2600 Bull St.
Columbia, SC 29201

ATTACHMENT 1

MARKED-UP TS AND TS BASES PAGES FOR CATAWBA

INSERTS

Insert 1 for TS 3.8.6:

Battery cell parameters for the channels of DC batteries shall be within the limits of Table 3.8.6-1 and the Diesel Generator (DG) Train A and Train B batteries shall be within the limits of temperature, level, and voltage.

Insert 2 for TS 3.8.6:

<u>OR</u>

One or more DG batteries with two or more connected cells < 1.36V.

Insert 3 for TS 3.8.6:

SR 3.8.6.5 Verify DG battery cell voltage ≥ 1.36 V on float charge.	7 days

---

Insert 4 for TS BASES 3.8.6:

This LCO delineates the limits on electrolyte temperature, level, float voltage, and specific gravity for the channels DC power source batteries. The LCO also addresses the trains of DC for the Diesel Generators limits on temperature, level, and float voltage. 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."

Insert 5 for TS BASES 3.8.6:

With one or more DG batteries with one or more battery cell(s) not within limits of level or temperature, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately. With one or more DG batteries with two or more battery cells not within limits of voltage, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately. Appropriate LCO(s) must then be entered for the DG supported by the inoperable DC subsystem. If the plant is in MODES 1 through 4, LCO 3.8.1, "AC Sources - Operating" is required to be entered.

If the DG is required to support equipment during MODES 5 or 6 or movement of irradiated fuel assemblies, regardless of operating mode, LCO 3.8.2, "AC Sources - Shutdown" is the appropriate LCO.

Insert 6 for TS BASES 3.8.6:

SR 3.8.6.5

Verifying battery individual cell voltage while on float charge for the DG batteries ensures each cell is capable of supporting its 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. The battery cell voltage limit of ≥ 1.36 V is consistent with the nominal design voltage of the battery and is based on the manufacturer's recommended minimum float charge voltage for a fully charged cell with adequate capacity. The battery is designed and sized with a capacity margin sufficient to allow up to one cell to be fully degraded with a voltage < 1.36 V assuming that no cells are jumpered out. The battery sizing calculations account for a degraded cell by assuming the degraded cell undergoes a worst-case polarity reversal during a design discharge. For this surveillance, a minimum of two cells shall be tested every seven days. The cells selected for testing shall be rotated on a monthly basis. The 7-day Frequency is consistent with the manufacturer's recommendations.

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources—Operating

LCO 3.8.4 Four channels of DC electrical power subsystems and the Train A and Train B Diesel Gènerator (DG) DC electrical power subsystems shall be OPERABLE.

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

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One channel of DC electrical power subsystem inoperable.	A.1 Verify associated bus tie breakers are closed between DC channels. AND A.2 Restore channel of DC electrical power subsystem to OPERABLE status.	8 hours 10 days
B. Required Action and Associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 5.	6 hours 36 hours
C. One or more DG DC electrical power subsystem(s) inoperable.	C.1 Enter applicable Condition(s) and Required Action(s) of LCO 3.8.1, "AC Sources - Operating", for the associated DG made inoperable.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. A and/or D channel of DC electrical power subsystem inoperable. AND Associated train of DG DC electrical power subsystem inoperable.	D.1 Enter applicable Condition(s) and Required Action(s) of LCO 3.8.9, "Distribution Systems-Operating", for the associated train of DC electrical power distribution subsystem made inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify DC channel and DG battery terminal voltage is ≥ 125 V on float charge.	7 days
~~SR 3.8.4.2~~	~~Verify DG battery cell voltage ≥ 1.36 V on float charge.~~ Relocate to T.S. 3.8.6 as new SR 3.8.6.5 + renumber successive steps	~~7 days~~
SR 3.8.4.~~3~~ 2	Verify no visible corrosion at the DC channel and DG battery terminals and connectors. OR (For the DC channel only) Verify battery connection resistance of these items is ≤ 1.5 E-4 ohm.	92 days

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.~~4~~ 3	Verify DC channel and DG battery cells, cell plates, and racks show no visual indication of physical damage or abnormal deterioration that could degrade battery performance.	18 months
SR 3.8.4.~~5~~ 4	Remove visible terminal corrosion, verify DC channel and DG battery cell to cell and terminal connections are clean and tight, and are coated with anti-corrosion material.	18 months
SR 3.8.4.~~6~~ 5	Verify DC channel battery connection resistance is ≤ 1.5 E-4 ohm.	18 months
SR 3.8.4.~~7~~ 6	Verify each DC channel battery charger supplies ≥ 200 amps and the DG battery charger supplies ≥ 75 amps with each charger at ≥ 125 V for ≥ 8 hours.	18 months
SR 3.8.4.~~8~~ 7	-----NOTES----- 1. The modified performance discharge test in SR 3.8.4.~~9~~ 8 may be performed in lieu of the service test in SR 3.8.4.~~8~~ 7. 2. This Surveillance shall not be performed for the DG batteries in MODE 1, 2, 3, or 4. ----- Verify DC channel and DG battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency 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.~~6~~ 8	-----NOTE----- This Surveillance shall not be performed for the DG batteries in MODE 1, 2, 3, or 4. --------------- Verify DC channel and DG 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 18 months when battery shows degradation or has reached 85% of expected life with capacity < 100% of manufacturer's rating AND -----NOTE----- Not applicable to DG batteries --------------- 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).

The 125 VDC electrical power system consists of four independent and redundant safety related Class 1E DC electrical power subsystems (Channels A, B, C, and D). Each channel consists of one 125 VDC battery (each battery is capable of supplying 2 channels of DC loads for a train), the associated battery charger(s) for each battery, and all the associated control equipment and interconnecting cabling.

There is one spare battery charger which provides backup service in the event that the preferred battery charger is out of service. If the spare battery charger is substituted for one of the preferred battery chargers, then the requirements of independence and redundancy between trains are maintained.

During normal operation, the 125 VDC load is powered from the battery chargers with the batteries floating on the system. In case of loss of normal power to the battery charger, the DC load is automatically powered from the station batteries.

The Channels A and D of DC electrical power subsystems or the Diesel Generator (DG) DC electrical power subsystems provide through auctioneering diode assemblies, the buses EDE for the A train and EDF for the B train to supply the control power for its associated Class 1E AC power load group, 4.16 kV switchgear, and 600 V load centers. The DC electrical power subsystems also provide DC electrical power to the inverters, which in turn power the AC vital buses.

BACKGROUND (continued)

The 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 V vital DC battery (EBA, EBB, EBC, EBD) has adequate storage capacity to carry the required duty cycle of its own load group and the loads of another load group for a period of two hours. Each 125 V vital DC battery is also capable of supplying the anticipated momentary loads during this two hour period. The 125 V DC DG batteries have adequate storage capacity to carry the required duty cycle for 2 hours.

Each 125 V vital DC battery is separately housed in a ventilated room apart from its charger and distribution centers. Each subsystem or channel 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, except for the spare battery charger which may be aligned to either train.

The batteries for each channel 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. Battery size is based on 125% of required capacity. The voltage limit is 2.13 V per cell, which corresponds to a total minimum voltage output of 125 V per battery discussed in the UFSAR, Chapter 8 (Ref. 4). The criteria for sizing large lead storage batteries are defined in IEEE-485 (Ref. 5).

Each channel of DC electrical power subsystem 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 capacity to restore the battery from the design minimum charge to its fully charged state within 8 hours while supplying normal steady state loads discussed in the UFSAR, Chapter 8 (Ref. 4).

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the UFSAR, Chapter 6 (Ref. 6), and in the UFSAR, Chapter 15 (Ref. 7), assume that Engineered Safety Feature (ESF) systems are OPERABLE. The DC electrical power system provides

APPLICABLE SAFETY ANALYSES (continued)

normal and emergency DC electrical power for the DGs, emergency auxiliaries, and control and switching during all MODES of operation.

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 unit. 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 (Ref. 8).

LCO

The DC electrical power subsystems, each subsystem consisting of one battery, battery charger and the corresponding control equipment and interconnecting cabling supplying power to the associated bus within the train 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 (AOO) or a postulated DBA. Loss of any train DC electrical power subsystem does not prevent the minimum safety function from being performed (Ref. 4).

An OPERABLE DC electrical power subsystem requires a battery and respective charger to be operating and connected to the associated DC bus.

APPLICABILITY

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

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOOs 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 and A.2

Condition A represents the loss of one channel for a DC source. The inoperable channel must be energized from an OPERABLE source within 8 hours. The inoperable channel may be powered from that train's other DC channel battery by closing the bus tie breakers. Each channel battery is sized and tested to supply two channels of DC for a period of two hours, in the event of a postulated DBA. Being powered from an OPERABLE source, the inoperable channel must be returned to OPERABLE status within 10 days or the plant must be prepared for a safe and orderly shutdown. The spare battery charger (ECS), which must be powered from the same train which it is supplying, may be substituted for the channel's battery charger to maintain a fully OPERABLE channel. In this case, Condition A is not applicable.

B.1 and B.2

If the inoperable channel of DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the unit must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit 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 unit conditions from full power conditions in an orderly manner and without challenging plant systems.

C.1

Condition C represents one train's loss of the ability to adequately supply the DG with the required DC power and the DG is inoperable. The DG is no longer capable of supplying the required 4.16 kV AC power and applicable Condition(s) and Required Action(s) for the AC sources must be entered immediately.

D.1

Being powered from auctioneering diode circuits from either the A channel of DC or the A Train of DG DC, distribution center EDE supplies breaker control power to the 4.16 kV AC and the 600 VAC switchgear, auxiliary feedwater pump controls, and other important DC loads. The EDF center is powered from the B Train of DG DC or the D channel of DC and provides DC power to Train B loads, similar to EDE center. With

BASES

ACTIONS (continued)

the loss of the channel DC power and the associated DG DC power, the load center power for the train is inoperable and the Condition(s) and Required Action(s) for the Distribution Systems must be entered immediately.

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the 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. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the initial voltages assumed in the battery sizing calculations. The 7 day Frequency is consistent with manufacturer recommendations and IEEE-450 (Ref. 9).

Relocate to TS Bases 3.8.6 as new SR 3.8.6.5 Revise wording per INSERT 6,

~~SR 3.8.4.2~~

~~Verifying battery individual cell voltage while on float charge for the DG batteries ensures each cell is capable of supporting 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. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the initial voltages assumed in the battery sizing calculations. For this surveillance two different cells shall be tested each month. The 7 day Frequency is consistent with manufacturer recommendations.~~

SR 3.8.4.~~3~~ 2

For the DC channel batteries, visual inspection to detect corrosion of the battery terminals 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 presence of visible corrosion does not necessarily represent a failure of this SR, provided an evaluation determines that the visible corrosion does not affect the OPERABILITY of the battery.

SURVEILLANCE REQUIREMENTS (continued)

For the DG batteries, visual inspection to detect corrosion of the battery terminals and connections provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance. The presence of visible corrosion does not necessarily represent a failure of this SR, provided an evaluation determines that the visible corrosion does not affect the OPERABILITY of the battery.

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.~~4~~ 3

For the DC channel batteries, 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 presence of physical damage or deterioration does not necessarily represent a failure of this SR, provided an evaluation determines that the physical damage or deterioration does not affect the OPERABILITY of the battery (its ability to perform its design function).

For the DG batteries, 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. Since the DG battery cell jars are not transparent, a direct visual inspection of the cell plates cannot be performed. Instead, the cell plates are inspected for physical damage and abnormal deterioration by: 1) visually inspecting the jar sides of each cell for excessive bowing and/or deformation, and 2) visually inspecting the electrolyte of each cell for abnormal appearance.

Operating experience has shown that these components usually pass the SR when performed at the 18 month Frequency. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

SR 3.8.4.~~5~~ 4 and SR 3.8.4.~~6~~ 5

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, as recommended by the manufacturer for the DG batteries, is used to help ensure good electrical

SURVEILLANCE REQUIREMENTS (continued)

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.~~5~~ 4.

For the DG batteries, the cell-to-cell terminal pole screws should be set from 14 to 15 foot-pounds of torque. Operating experience has shown that these components usually pass the SR when performed at the 18 month Frequency. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

SR 3.8.4.~~7~~ 6

This SR requires that each battery charger for the DC channel be capable of supplying at least 200 amps and at least 75 amps for the DG chargers. All chargers shall be tested at a voltage of at least 125 V for ≥ 8 hours. These requirements are based on the design capacity of the chargers (Ref. 4). According to Regulatory Guide 1.32 (Ref. 10), the battery charger supply is required 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 unit during these demand occurrences. The minimum required amperes and duration ensures that these requirements can be satisfied.

The Surveillance Frequency is acceptable, given the unit 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.~~8~~ 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 the design duty cycle requirements as specified in Reference 4. The DC channel batteries are tested to supply a current ≥ 522.14 amps for the first minute, then ≥ 267.71 amps for the next 9 minutes, ≥ 376.15 amps for the next 10 minutes, and ≥ 281.94 amps for the next 100 minutes. Terminal voltage is required to remain ≥ 110.4 volts during this test. The

BASES

SURVEILLANCE REQUIREMENTS (continued)

DG batteries are tested to supply a current ≥ 218.5 amps for the first minute, then ≥ 42.5 amps for the next 10 minutes, then ≥ 121.8 amps for the next minute, then ≥ 42.5 amps for the remaining 108 minutes. Terminal voltage is required to remain ≥ 105 volts during this test.

7

Except for performing SR 3.8.4.~~8~~ for the DC channel batteries with the unit on line, the Surveillance Frequency of 18 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. 10), which states 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 modified performance discharge test is a performance discharge test that is augmented to include the high-rate, short duration discharge loads (during the first minute and 11-to-12 minute discharge periods) of the service test. The duty cycle of the modified performance test must fully envelope the duty cycle of the service test if the modified performance discharge test is to be used in lieu of the service test. Since the ampere-hours removed by the high-rate, short duration discharge periods of the service test represents a very small portion of the battery capacity, the test rate can be changed to that for the modified performance discharge 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 rates of the duty cycle). This will often confirm the battery's ability to meet the critical periods 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 would perturb the electrical distribution system and challenge safety systems.

8

SR 3.8.4.~~9~~

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

SURVEILLANCE REQUIREMENTS (continued)

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 SR 3.8.4.~~8~~ 7. Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.4.~~9~~ 8; however, only the modified performance discharge test may be used to satisfy SR 3.8.4.~~9~~ 8 while satisfying the requirements of SR 3.8.4.~~8~~ 7 at the same time.

The acceptance criteria for this Surveillance are consistent with IEEE-450 (Ref. 9). This reference recommends 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.

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 18 months. However (for DC vital batteries only), 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 average capacity on the previous performance tests or when it is ≥ 10% below the manufacturer's rating. These Frequencies are consistent with the recommendations in IEEE-450 (Ref. 9). This SR is modified by a Note which is applicable to the DG batteries only. The reason for the Note is that performing the Surveillance would perturb the associated electrical distribution system and challenge safety systems.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 17.
2. Regulatory Guide 1.6, March 10, 1971.
3. IEEE-308-1971 and 1974.
4. UFSAR, Chapter 8.
5. IEEE-485-1983, June 1983.
6. UFSAR, Chapter 6.

REFERENCES (continued)

7. UFSAR, Chapter 15.
8. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
9. IEEE-450-1975 and/or 1980.
10. Regulatory Guide 1.32, February 1977.

3.8 ELECTRICAL POWER SYSTEMS

3.8.5 DC Sources—Shutdown

LCO 3.8.5 The following shall be OPERABLE:

a. Two channels of DC electrical power subsystems and a train of DG DC electrical power subsystem capable of supplying one train of the DC electrical power distribution subsystem(s) required by LCO 3.8.10, "Distribution Systems-Shutdown," and

b. One source of DC electrical power, other than that required by LCO 3.8.5.a, capable of supplying the remaining train of the DC electrical power distribution subsystem(s) when required by LCO 3.8.10.

APPLICABILITY: MODES 5 and 6,
During movement of irradiated fuel assemblies.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more required channel(s) of DC electrical power subsystems or required DG DC electrical power subsystem inoperable.	A.1.1 Declare affected required feature(s) inoperable. <u>OR</u> A.2.1 Suspend CORE ALTERATIONS. <u>AND</u> A.2.2 Suspend movement of irradiated fuel assemblies. <u>AND</u>	Immediately Immediately Immediately (continued)

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. (continued)	A.2.3 Initiate action to suspend operations involving positive reactivity additions.	Immediately
	AND	
	A.2.4 Initiate action to restore required DC electrical power subsystems to OPERABLE status.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.5.1	-----NOTE----- The following SRs are not required to be performed: SR 3.8.4.~~7~~ 6, SR 3.8.4.~~8~~ 7, and SR 3.8.4.~~9~~ 8. ---------- For DC sources required to be OPERABLE, the following SRs are applicable: SR 3.8.4.1 SR 3.8.4.4 SR 3.8.4.7 SR 3.8.4.2 SR 3.8.4.5 SR 3.8.4.8 SR 3.8.4.3 SR 3.8.4.6 ~~SR 3.8.4.9~~	In accordance with applicable SRs

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.5 DC Sources—Shutdown

BASES

BACKGROUND

A description of the DC sources is provided in the Bases for LCO 3.8.4, "DC Sources—Operating."

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident and transient analyses in the UFSAR, Chapter 6 (Ref. 1) and Chapter 15 (Ref. 2), assume that Engineered Safety Feature systems are OPERABLE. The DC electrical power system provides normal and emergency DC electrical power for the diesel generators, emergency auxiliaries, and control and switching during all MODES of operation.

The OPERABILITY of the DC subsystems is consistent with the initial assumptions of the accident analyses and the requirements for the supported systems' OPERABILITY.

The OPERABILITY of the minimum DC electrical power sources during MODES 5 and 6 and during movement of irradiated fuel assemblies ensures that:

a. The unit can be maintained in the shutdown or refueling condition for extended periods;

b. Sufficient instrumentation and control capability is available for monitoring and maintaining the unit status; and

c. Adequate DC electrical power is provided to mitigate events postulated during shutdown, such as a fuel handling accident.

The DC sources satisfy Criterion 3 of 10 CFR 50.36 (Ref. 3).

LCO

The DC electrical power subsystems, with 1) at least one subsystem consisting of two batteries, one battery charger per battery; and 2) when the redundant train of DC electrical power distribution subsystem is required by LCO 3.8.10, the other subsystem consisting of either a battery or a charger, and 3) the corresponding control equipment

LCO (continued)

and interconnecting cabling within the train, are required to be OPERABLE to support required trains of the distribution systems required OPERABLE by LCO 3.8.10, "Distribution Systems—Shutdown." This ensures the availability of sufficient DC electrical power sources to operate the unit in a safe manner and to mitigate the consequences of postulated events during shutdown (e.g., fuel handling accidents).

APPLICABILITY

The DC electrical power sources required to be OPERABLE in MODES 5 and 6, and during movement of irradiated fuel assemblies, provide assurance that:

a. Required features to provide adequate coolant inventory makeup are available for the irradiated fuel assemblies in the core;

b. Required features needed to mitigate a fuel handling accident are available;

c. Required features necessary to mitigate the effects of events that can lead to core damage during shutdown are available; and

d. Instrumentation and control capability is available for monitoring and maintaining the unit in a cold shutdown condition or refueling condition.

The DC electrical power requirements for MODES 1, 2, 3, and 4 are covered in LCO 3.8.4.

ACTIONS

A.1.1, A.2.1, A.2.2, A.2.3, and A.2.4

If two trains are required by LCO 3.8.10, the remaining train with DC power available may be capable of supporting sufficient systems to allow continuation of CORE ALTERATIONS and fuel movement. By allowing the option to declare required features inoperable with the associated DC power source(s) inoperable, appropriate restrictions will be implemented in accordance with the affected required features LCO ACTIONS. In many instances, this option may involve undesired administrative efforts. Therefore, the allowance for sufficiently conservative actions is made (i.e., to suspend CORE ALTERATIONS, movement of irradiated fuel assemblies, and operations involving positive reactivity additions) that could result in loss of required SDM (MODE 5) or required boron concentration (MODE 6). Suspending positive reactivity additions that could result in failure to meet the minimum SDM or boron concentration

BASES

ACTIONS (continued)

limits is required to assure continued safe operation. Introduction of coolant inventory must be from sources that have a boron concentration greater than that what would be required in the RCS for minimum SDM or refueling boron concentration. This may result in an overall reduction in RCS boron concentration, but provides acceptable margin to maintaining subcritical operation. Introduction of temperature changes including temperature increases when operating with a positive MTC must also be evaluated to ensure they do not result in a loss of required SDM.

Suspension of these activities shall not preclude completion of actions to establish a safe conservative condition. These actions minimize probability of the occurrence of postulated events. It is further required to immediately initiate action to restore the required DC electrical power subsystems and to continue this action until restoration is accomplished in order to provide the necessary DC electrical power to the unit safety systems.

The Completion Time of immediately is consistent with the required times for actions requiring prompt attention. The restoration of the required DC electrical power subsystems should be completed as quickly as possible in order to minimize the time during which the unit safety systems may be without sufficient power.

SURVEILLANCE REQUIREMENTS

SR 3.8.5.1

8

SR 3.8.5.1 requires performance of all Surveillances required by SR 3.8.4.1 through SR 3.8.4.~~6~~. Therefore, see the corresponding Bases for LCO 3.8.4 for a discussion of each SR.

This SR is modified by a Note. The reason for the Note is to preclude requiring the OPERABLE DC sources from being discharged below their capability to provide the required power supply or otherwise rendered inoperable during the performance of SRs. It is the intent that these SRs must still be capable of being met, but actual performance is not required.

REFERENCES

1. UFSAR, Chapter 6.
2. UFSAR, Chapter 15.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).

3.8 ELECTRICAL POWER SYSTEMS

3.8.6 Battery Cell Parameters

DELETE + INSERT 1

LCO 3.8.6 ~~Battery cell parameters for the channels of DC batteries shall be within the limits of Table 3.8.6-1 and the Diesel Generator (DG) Train A and Train B batteries shall be within the limits of temperature and level.~~

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

ACTIONS

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more channel(s) of DC 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 (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action and associated Completion Time of Condition A not met. OR One or more channel(s) of DC batteries with average electrolyte temperature of the representative cells < 60°F. OR One or more channel(s) of DC batteries with one or more battery cell parameters not within Category C values.	B.1 Declare associated battery inoperable.	Immediately
C. One or more DG batteries with electrolyte level not at or above the low mark and not at or below the high mark. OR One or more DG batteries with average electrolyte temperature of the representative cells < 60°F. INSERT 2 →	C.1 Enter applicable Condition(s) and Required Action(s) of LCO 3.8.1, "AC Sources - Operating", or LCO 3.8.2, "AC Sources - Shutdown" for the associated DG made inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.6.1	Verify battery cell parameters of the channels of DC batteries meet Table 3.8.6-1 Category A limits.	7 days
SR 3.8.6.2	Verify electrolyte level of DG batteries is at or above low mark and at or below high mark.	7 days
SR 3.8.6.3	Verify battery cell parameters of the channels of DC batteries meet Table 3.8.6-1 Category B limits.	92 days AND Once within 7 days after a battery discharge < 110 V AND Once within 7 days after a battery overcharge > 150 V
SR 3.8.6.4	Verify average electrolyte temperature for the channels of DC and DG batteries of representative cells is ≥ 60°F.	92 days

INSERT 3

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 LIMITS FOR EACH CONNECTED CELL
Electrolyte Level	> Minimum level indication mark, and ≤ ¼ inch above maximum level indication mark[(a)]	> Minimum level indication mark, and ≤ ¼ 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 or ≥ 1.195 AND Average of all connected cells ≥ 1.195

(a) It is acceptable for the electrolyte level to temporarily increase above the specified maximum 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.

(c) A battery charging current of < 2 amps when on float charge is acceptable for meeting specific gravity limits following a battery recharge, for a maximum of 7 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 7 day allowance.

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.6 Battery Cell Parameters

BASES

DELETE + INSERT 4

BACKGROUND

~~This LCO delineates the limits on electrolyte temperature, level, float voltage, and specific gravity for the channels DC power source batteries. The LCO also addresses the trains of DC for the Diesel Generators limits on temperature and level. 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."~~

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in the UFSAR, Chapter 6 (Ref. 1) and Chapter 15 (Ref. 2), assume Engineered Safety Feature systems are OPERABLE. The DC electrical power system provides normal and emergency DC electrical power for the diesel generators, emergency auxiliaries, and control and switching during all MODES of operation.

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 unit. This includes maintaining at least one train 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 Criterion 3 of 10 CFR 50.36 (Ref. 3).

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 limits are conservatively established, allowing continued DC electrical system function even with Category A and B limits not met.

BASES

APPLICABILITY	The battery cell parameters are required solely for the support of the associated DC electrical power subsystems. Therefore, battery electrolyte is 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 or 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.

ACTIONS (continued)

B.1

With one or more batteries with one or more battery cell parameters outside the Category C limit for any connected cell, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding DC electrical power subsystem 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, are also cause for immediately declaring the associated DC electrical power subsystem inoperable.

C.1

DELETE + INSERT 5

~~With one or more DG batteries with one or more battery cell(s) not within the limits of level or temperature, sufficient capacity to supply the required load for the DG is not assumed and the corresponding DC electrical power subsystem must be declared inoperable immediately. Appropriate LCO(s) must then be entered for the DG supported by the inoperable DC subsystem. If the plant is in MODES 1 through 4, LCO 3.8.1, "AC Sources—Operating" is required to be entered.~~

~~If the DG is required to support equipment during MODES 5 or 6 or movement of irradiated fuel assemblies, regardless of operating mode, LCO 3.8.2, "AC Sources—Shutdown," is the appropriate LCO.~~

SURVEILLANCE REQUIREMENTS

SR 3.8.6.1

This SR verifies that Category A battery cell parameters are consistent with IEEE-450 (Ref. 4), 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

This SR verifies the DG battery cell parameter of level via regular battery inspection (at least once every 7 days). The electrolyte level is monitored in order to maintain battery performance and effectiveness. The 7 day Frequency has been shown acceptable through operating experience.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.6.3

The quarterly inspection of the channels of DC batteries for specific gravity and voltage is consistent with IEEE-450 (Ref. 4). In addition, within 24 hours of a battery discharge < 110 V or a battery overcharge > 150 V, 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, 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. 4), 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 3.8.6.4

This Surveillance verification that the average temperature of representative cells is ≥ 60°F, is consistent with a recommendation of IEEE-450 (Ref. 4), 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.

The term "representative cells" replaces the fixed number of "six connected cells", consistent with the recommendations of IEEE-450 (Ref. 4) to provide a general guidance to the number of cells adequate to monitor the temperature of the battery cells as an indicator of satisfactory performance. For some cases, the number of cells may be less than six, in other conditions, the number may be more.

INSERT 6

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.

BASES

SURVEILLANCE REQUIREMENTS (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. 4), 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. 4) 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. 4), 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. 4), 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

BASES

SURVEILLANCE REQUIREMENTS (continued)

(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 are based on IEEE-450 (Ref. 4), 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 limit 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. 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. 4). 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 7 days following a battery

BASES

SURVEILLANCE REQUIREMENTS (continued)

recharge. Within 7 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 7 days.

The value of 2 amps used in footnote (b) and (c) is the nominal value for float current established by the battery vendor as representing a fully charged battery with an allowance for overall battery condition.

REFERENCES

1. UFSAR, Chapter 6.
2. UFSAR, Chapter 15.
3. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).
4. IEEE-450-1980.

ATTACHMENT 2

DESCRIPTION OF PROPOSED CHANGES AND TECHNICAL JUSTIFICATION

DESCRIPTION OF PROPOSED CHANGES AND TECHNICAL JUSTIFICATION

Background Information:

In 1998 (U2) and 1999(U1) the Emergency Diesel Generator batteries were replaced with Ni-Cd cells. Also, this modification installed battery cells with a higher Ampere-Hour capacity, 237Ah to 277Ah, and upsized the battery to 94 cells from the former 92 cell battery to add additional margin. Under the current Technical Specification requirements, an Emergency DG found to have a DG battery with a cell below 1.36 V shall be immediately declared inoperable. This places the affected unit into a 72-hour shutdown action. The subsequent corrective actions to restore operability typically involve jumpering out or replacing the low-voltage cell. Either action takes approximately 4-6 hours, during which time the affected Emergency DG is unavailable. This change will more accurately reflect the actual impact of a single battery cell failure on the actual diesel generator operability. This revision will also minimize unnecessary entries into a Technical Specification Action Statement and battery unavailability due to an overly conservative TS requirement.

Description of Proposed Changes:

Duke Energy Corporation is proposing to revise Technical Specification Sections 3.8.4, "DC Sources - Operating"; 3.8.5, "DC Sources - Shutdown"; and 3.8.6, "Battery Cell Parameters", to allow a Diesel Generator battery to remain operable with no more than one cell < 1.36 Vdc on float charge. The specific revisions are as follows:

1. Delete SR 3.8.4.2 and associated bases from section 3.8.4. SR 3.8.4.2 currently reads as follows:

   SR 3.8.4.2: Verify DG battery cell voltage ≥ 1.36 V on float charge.

   Renumber existing SR 3.8.4.3 through SR 3.8.4.9 and the associated bases.

   This change is simply relocating this surveillance from TS 3.8.4, "DC Sources-Operating" to a more appropriate Technical Specification. TS 3.8.6, "Battery Cell Parameters" is the new location for the surveillance. Note item #6 in this section, which adds the new SR 3.8.6.5. The wording in the Bases section for SR

3.8.6.5 will be revised for clarity, also: Under the Bases section the current wording:

"For this surveillance, two different cells shall be tested each month."

will be revised for clarity as follows to state:

"For this surveillance, a minimum of two cells shall be tested every 7 days. The cells selected for testing shall be rotated on a monthly basis."

2. Revise SR 3.8.5.1 to reflect the deletion of SR 3.8.4.2 as follows:

SURVEILLANCE	FREQUENCY
SR 3.8.5.1 -------------------------- NOTE--------------------------------- --- The following SRs are not required to be performed: SR 3.8.4.6, SR 3.8.4.7, and SR 3.8.4.8. ---------------------------------- ---------------------------------- For DC sources required to be OPERABLE, the following SRs are applicable: SR 3.8.4.1 SR 3.8.4.4 SR 3.8.4.7 SR 3.8.4.2 SR 3.8.4.5 SR 3.8.4.8 SR 3.8.4.3 SR 3.8.4.6	**In accordance with applicable SRs**

3. Revise the text for SR 3.8.5.1 in Bases Section B 3.8.5 as follows:

   <u>**SR 3.8.5.1**</u>

   SR 3.8.5.1 requires performance of all Surveillances required by SR 3.8.4.1 through SR 3.8.4.8. Therefore, see the corresponding Bases for LCO 3.8.4 for a discussion of each SR.

   This SR is modified by a Note. The reason for the Note is to preclude requiring the OPERABLE DC sources from being discharged below their capability to provide the required power supply or otherwise rendered inoperable during the performance of SRs. It is the intent that these SRs must still be capable of being met, but actual performance is not required.

4. Revise the text in Technical Specification 3.8.6 as follows:

   LCO — **Battery cell parameters for the channels of DC batteries shall be within the limits of Table 3.8.6-1 and the Diesel Generator (DG) Train A and Train B batteries shall be within the limits of temperature, level, and voltage.**

5. Revise the text in the Background section of B 3.8.6 as follows:

   BACKGROUND — **This LCO delineates the limits on electrolyte temperature, level, float voltage, and specific gravity for the channels DC power source batteries. The LCO also addresses the trains of DC for the Diesel Generators limits on temperature, level, and float voltage. 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."**

6. Add a new surveillance requirement, SR. 3.8.6.5, to section 3.8.6 that reads as follows:

SURVEILLANCE	FREQUENCY
SR 3.8.6.5 Verify DG battery cell voltage ≥ 1.36 V on float charge.	**7 days**

7. Add the following text for SR 3.8.6.5 to TS Bases 3.8.6:

<u>SR 3.8.6.5</u>

Verifying battery individual cell voltage while on float charge for the DG batteries ensures each cell is capable of supporting its 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. The battery cell voltage limit of ≥ 1.36 V is consistent with the nominal design voltage of the battery and is based on the manufacturer's recommended minimum float charge voltage for a fully charged cell with adequate capacity. The battery is designed and sized with a capacity margin sufficient to allow up to one cell to be fully degraded with a voltage < 1.36 V assuming that no cells are jumpered out. The battery sizing calculations account for a degraded cell by assuming the degraded cell undergoes a worst-case polarity reversal during a design discharge. For this surveillance, a minimum of two cells shall be tested every seven days. The cells selected for testing shall be rotated on a monthly basis. The 7-day Frequency is consistent with the manufacturer's recommendations.

8. Revise the text for Action C.1 in TS Bases 3.8.6 as follows:

With one or more DG batteries with one or more battery cell(s) not within limits of level or temperature, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately. With one or more DG batteries with two or more battery cells not within limits of voltage, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately. Appropriate LCO(s) must then be entered for the DG supported by the inoperable DC subsystem. If the plant is in MODES 1 through 4, LCO 3.8.1, "AC Sources - Operating" is required to be entered.

If the DG is required to support equipment during MODES 5 or 6 or movement of irradiated fuel assemblies, regardless of operating mode, LCO 3.8.2, "AC Sources - Shutdown" is the appropriate LCO.

9. Revise Condition C in Technical Specification 3.8.6 by adding a new condition as shown in italics below:

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One or more DG batteries with electrolyte level not at or above the low mark and not at or below the high mark. <u>OR</u> One or more DG batteries with average electrolyte temperature of the representative cells < 60ºF. ***<u>OR</u>*** ***One or more DG batteries with two or more connected cells < 1.36V.***	C.1 Enter applicable Condition(s) and Required Action(s) of LCO 3.8.1, "AC Sources - Operating", or LCO 3.8.2, "AC Sources - Shutdown" for the associated DG made inoperable.	Immediately

Regulatory Requirements and General Discussion

Technical Justification:

The DG (Emergency Diesel Generator) batteries each consist of 94 SAFT SBM277 pocket-plate Ni-Cd cells. As described on Attachment 5 (the manufacturer's technical justification), pocket plate Ni-Cd battery cells exhibit an occasional phenomenon in float service where a particle of active material lodges between the plates and causes a high-resistance internal short. In some cases, the resistance of the short may be low enough to cause the cell to slowly discharge. Over time, this condition normally reverses itself, and the cell recovers without any degradation; however, in the short term the discharging cell will typically have a float voltage less than 1.36V. As described in Attachment 5, if a battery containing a low-voltage, low-capacity cell is deeply discharged due to a high-resistance internal short, there is a possibility that the affected cell may undergo polarity reversal when subjected to a design discharge. In effect, the discharge current from the remaining cells acts to reverse charge the low-voltage, low-capacity cell. Ni-Cd cells are designed with excess negative capacity such that the positive will be depleted and reverse before the negative under discharge conditions. When the positive depletes and reverses under a discharge condition, the cell voltage will typically be -0.3V. The amount of excess negative capacity (versus the positive) is such that the cell reverse voltage will remain at approximately -0.3V for an extended period of time. If a cell is at a very low state of charge at the beginning of discharge and the discharge duration is long enough, the negative will eventually be depleted and go into reversal as well. The magnitude of reversal is dependent on the discharge current and ampere-hour capacity of the cell. For an SBM277 cell discharging at 110 amps (which is 40% of its capacity rating), the maximum cell reverse voltage would be -1.80V. The magnitude of the reverse voltage would be somewhat less for lower discharge currents.

As described in Attachment 5, the worst-case scenario would be one in which a low-voltage, low-capacity cell is discharged by a high-resistance internal short to the point where the positive plate is fully depleted. Once the positive plate is fully depleted, the electrochemical reaction stops and prevents further depletion of the negative plate. Under these conditions, a cell subjected to a design discharge would go into immediate reversal of approximately -0.3V, but it would take several minutes for the cell to go into a full reversal of -1.80V (assuming a maximum load current of 110 amps). Though the LOCA-BO duty cycle - the worst-case design discharge profile - includes some discharge currents higher than 110 amps, these occur during the first minute when a full cell reversal cannot occur. The discharge currents during the remainder of the LOCA-BO duty cycle, when full cell reversal can occur, are sufficiently below the discharge current (110 amps) assumed for a full reverse voltage of -1.80V.

Assuming that one cell in a 94-cell battery is at a full-reverse voltage of -1.80V, the remaining cells would be required to supply 106.80V, or 1.1484V/cell, in order to maintain a minimum battery terminal voltage of 105.0V. Per Attachment 5, the manufacturer has extrapolated new sizing factors for an end-voltage of 1.1484V and used the new sizing factors to recalculate the battery capacity required to satisfy the design basis requirements (LOCA-BO design basis discharge profile). The load profile data and sizing methodology was taken from 125 Vdc Diesel Auxiliary Power Battery Sizing Calculations, CNC-1381.05-00-0050 and CNC-1381.05-00-0150. Considering all possible loading scenarios, the minimum capacity margin available with one cell assumed to be in full reversal (-1.80V) was calculated to be 34%. This assumes the battery is at an end-of-life capacity of 80%, the electrolyte temperature is at the design-minimum of 60ºF, and that no cells are jumpered out.

Based on the discussion above and the results of the battery sizing calculations documented on Attachment 5, a DG battery remains operable and fully capable of satisfying its design requirements with one cell <1.36V on an indefinite basis.

ATTACHMENT 3

NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

Requested Change:

Revise Technical Specification (TS) Sections 3.8.4, "DC Sources - Operating"; 3.8.5 - "DC Sources - Shutdown"; and 3.8.6, "Battery Cell Parameters", to allow a Diesel Generator (DG) Battery to remain operable with no more than one cell < 1.36 Volts DC (Vdc) on float charge.

No Significant Hazards Determination:

The following discussion is a summary of the evaluation of the changes contained in these proposed amendments against the 10 CFR 50.92(c) requirements to demonstrate that all three standards are satisfied. A no significant hazards consideration is indicated if operation of the facility in accordance with the proposed amendments would not:

1. Involve a significant increase in the probability or consequences of an accident previously evaluated, or

2. Create the possibility of a new or different kind of accident from any accident previously evaluated, or

3. Involve a significant reduction in a margin of safety.

First Standard

Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?

No. The DC electrical power system provides normal and emergency DC electrical power for the diesel generators, emergency auxiliaries, and control and switching during all modes of operation. This change will not affect or degrade the ability of the DC Electrical Power Systems to perform their specified safety function.

The only effect on systems, structures and components (SSCs) by this change is that with one DG battery with one cell less than 1.36 volts the system will still be considered operable. With one or more DG batteries with one or more battery cell(s) not within limits of level or temperature, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately. With one or more DG batteries with two or more battery cells not within limits of voltage, sufficient capacity to supply the required load for the DG is not assumed, and the corresponding DC electrical power subsystem must be declared inoperable immediately.

Surveillance (SR) 3.8.4.2 is being relocated to TS 3.8.6 as a new surveillance and the wording of the Bases section is being revised for clarity as follows: "For this surveillance, a minimum of two cells shall be tested every seven days. The cells selected for testing shall be rotated on a monthly basis." The new SR 3.8.6.5 will check the DG battery cell voltage on selected cells to ensure they are greater than or equal to 1.36 volts on a seven day frequency. This test will continue to assure that the batteries are available to perform their design functions.

This amendment will not change any previously evaluated accidents such as "Loss of Non-Emergency AC Power to Station Auxiliaries (Blackout)", "Loss of Coolant Accident (LOCA)", and "LOCA/Blackout". The prevention and mitigation of these accidents is also not affected by this change.

The likelihood of a malfunction of the batteries is not increased by this change in the surveillances. The systems will continue to be able to perform their design functions of supplying emergency power during the evaluated accidents listed above. Therefore, the changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

Second Standard

Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?

No. This change does not involve a physical alteration to the plant (i.e., no new or different type of equipment will be installed) or a change in the methods governing normal plant operation. The change does not alter assumptions made in the safety analysis or licensing basis. This change will not affect or degrade the ability of the DC Electrical Power Systems to perform their specified safety function. Therefore, the change does not create the possibility of a new or different kind of credible accident from any accident previously evaluated.

Third Standard

Does the proposed change involve a significant reduction in a margin of safety?

No. Assuming that one cell in a 94-cell battery is at a full-reverse voltage of -1.80V, the remaining cells would be required to supply 106.80V, or 1.1484V/cell, in order to maintain a minimum battery terminal voltage of 105.0V. The manufacturer has extrapolated new sizing factors for an end-voltage of 1.1484V and used the new sizing factors to recalculate the battery capacity required to satisfy the design basis requirements. The load profile data and sizing methodology was taken from 125 Vdc Diesel Auxiliary Power Battery Sizing Calculations. Considering all possible loading scenarios, the minimum capacity margin available with one cell assumed to be in full reversal (-1.80V) was calculated to be 34%. This assumes the battery is at an end-of-life capacity of 80%, the electrolyte temperature is at the design-minimum of 60ºF, and that no cells are jumpered out.

Based on the discussion above and the results of the battery sizing calculations, a DG battery remains operable and fully capable of satisfying its design requirements with one cell <1.36V on an indefinite basis. Therefore, the proposed changes listed above do not involve a significant reduction in a margin of safety.

ATTACHMENT 4

ENVIRONMENTAL IMPACT STATEMENT CONSIDERATION

ENVIRONMENTAL IMPACT STATEMENT CONSIDERATION

Pursuant to 10 CFR 51.22(b), an evaluation of this license amendment request has been performed to determine whether or not it meets the criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) of the regulations.

This amendment revises Technical Specification (TS) Sections 3.8.4, "DC Sources - Operating"; 3.8.5 - "DC Sources - Shutdown"; and 3.8.6, "Battery Cell Parameters", to allow a Diesel Generator (DG) Battery to remain operable with no more than one cell < 1.36 Volts DC (Vdc) on float charge.

Implementation of this amendment will have no adverse impact upon the Catawba units; neither will it contribute to any additional quantity or type of effluent being available for adverse environmental impact or personnel exposure.

It has been determined there is:

1. No significant hazards consideration,

2. No significant change in the types, or significant increase in the amounts, of any effluents that may be released offsite, and

3. No significant increase in individual or cumulative occupational radiation exposures involved.

Therefore, this amendment to the Catawba Technical Specifications and associated bases meets the criteria of 10 CFR 51.22(c)(9) for categorical exclusion from an environmental impact statement.

ATTACHMENT 5

Manufacturer's Technical Justification, Battery Resizing Calculations, and Supporting Documentation

SAFT

Duke Energy – Catawba Station
Battery Resizing Project

Summary

Sizing calculations for the Catawba Emergency Diesel Generator batteries show that there is sufficient installed capacity under all load conditions to support one cell in full reversal. It therefore follows that these batteries should be allowed to operate with one cell at low float voltage.

Cell Reversal Scenario

Batteries comprising 94 Saft SBM277 pocket-plate Ni-Cd cells provide standby power to the Catawba Emergency Diesel Generators. An occasional phenomenon with these cells in float service is that a small particle of active material may lodge between the plates, causing a high-resistance internal short. While this condition is normally reversible, in the short term it may affect the available capacity from the battery. If the short circuit current exceeds the float current, the cell will slowly discharge. This can be observed by means of float voltage measurements, with a discharging cell typically showing a float voltage below about 1.36V.

If a battery containing a low-voltage, low-capacity cell is deeply discharged, there is a possibility that the affected cell may undergo polarity reversal. Because of its reduced state of charge, the cell voltage drops more rapidly and ultimately collapses; the remaining cells continue to support the load and their discharge current effectively becomes a reverse charging current for the low cell.

Ni-Cd cells are designed with excess negative capacity, so the positive plate reverses before the negative. At this point the cell voltage is typically around –0.3V. This condition lasts for an extended time, and typically the discharge is terminated before full reversal is encountered. If the affected cell was at a very low state of charge at the beginning of the discharge, it is possible that the reversal condition may last long enough for the negative to be fully depleted and to go into reversal also. For an SBM cell discharging at 20% of the rated capacity (55A for the SBM277), the cell voltage will increase negatively to approximately –1.75V, as shown in the accompanying CELL_REV.PDF file. This shows the negative plate stabilizing at 1.97V (relative to a zinc reference electrode) and the positive at 0.22V relative to zinc. The resulting cell voltage is 0.22 – 1.98 = –1.75V.

The worst-case condition is one in which a high-resistance short has completely depleted the positive plate capacity. The short cannot fully discharge the negative, since the reaction at the positive has stopped and any electrochemical process requires balancing reactions to be occurring at both the positive and the negative. On discharge the positive would reverse immediately, but it would take several minutes for the negative to reverse, based on the load currents used in these calculations.

(Note that a low-resistance short does not represent a worse condition than the one described above, since it would not be cleared on discharge and the short would carry some of the load current, resulting in a lesser reversal voltage.)

To be conservative, we have considered a maximum cell reversal voltage of –1.80V. Based on the test data this would be equivalent to a discharge current of at least 40% of the battery capacity, or 110A for the SBM277. Although the LOCA-BO duty cycles include some higher load currents, they are limited to the first minute of discharge when full cell reversal cannot occur. Where full reversal is a possibility later in the duty cycle, all loads are at least 30% below our 'safe' level.

From a battery viewpoint, if one cell is contributing –1.80V the remaining 93 cells must provide at least 106.80V, or 1.1484V/cell, to maintain the overall battery voltage at or above the minimum level of 105.0V.

It should be noted that a temporary low voltage condition lasting for several months is not damaging to Ni-Cd cells, nor is polarity reversal during discharge. In fact, vigorous gassing during reversal may help to clear the internal short, allowing the cell to recharge normally.

Battery Resizing Calculations

To validate the operation of the Catawba Emergency Diesel Generator batteries with one low voltage cell (and hence the possibility of that cell going into full reversal on discharge), the required capacity for each of the load profiles has been recalculated for an end-of-discharge voltage of 1.1484V/cell. The calculations are in accordance with IEEE Std 1115-2000, *IEEE Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications.*

The necessary curve of capacity rating factors (K_t) for these calculations, based on prolonged float operation, was produced in Microcal Origin 7.0 and is shown in Figure 1 below.

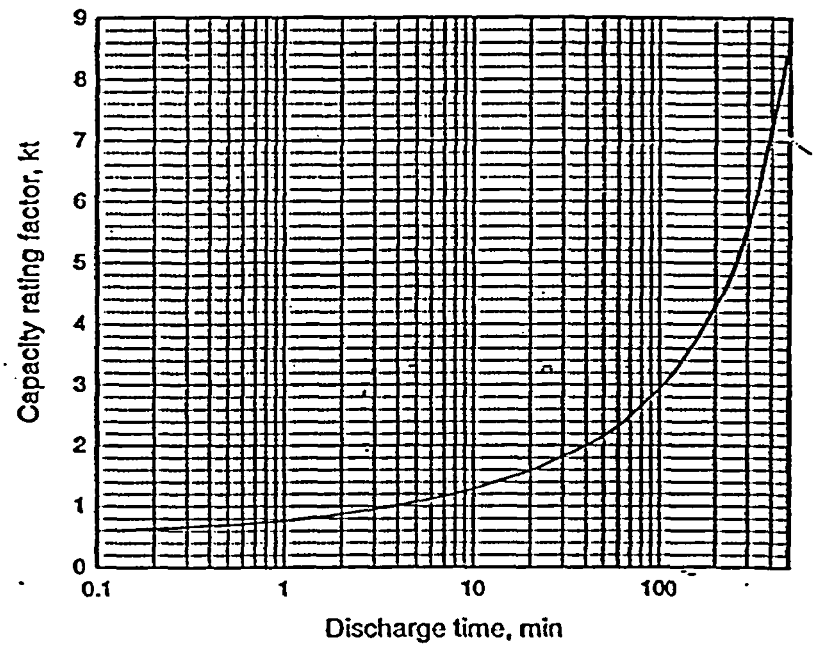


Figure 1 – Capacity rating factors for SBM cells discharging to 1.1484V/cell at 77°F

The Origin software allows highly accurate readings to be taken from such curves by plotting the x and y coordinates from a magnified view of the chart. An example of this is shown in the screen shot in Figure 2, detailing the coordinates for a discharge time of 2 minutes (x) and a K_t factor of 0.870.

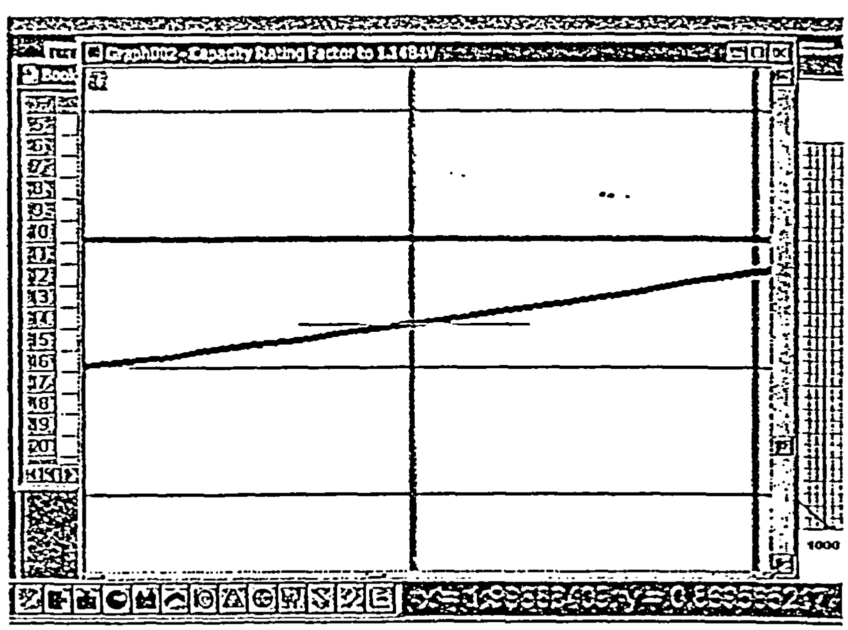


Figure 2 – Coordinate readout for capacity rating factor curve in Origin 7.0

The K_t factors used in the sizing calculations are shown in the 'Sizing Factors' worksheet of the accompanying Excel workbook, 'Duke Catawba Sizing Sheets.xls,' along with the corresponding temperature factors (T_t) for operation at the specified temperature of 60°F.

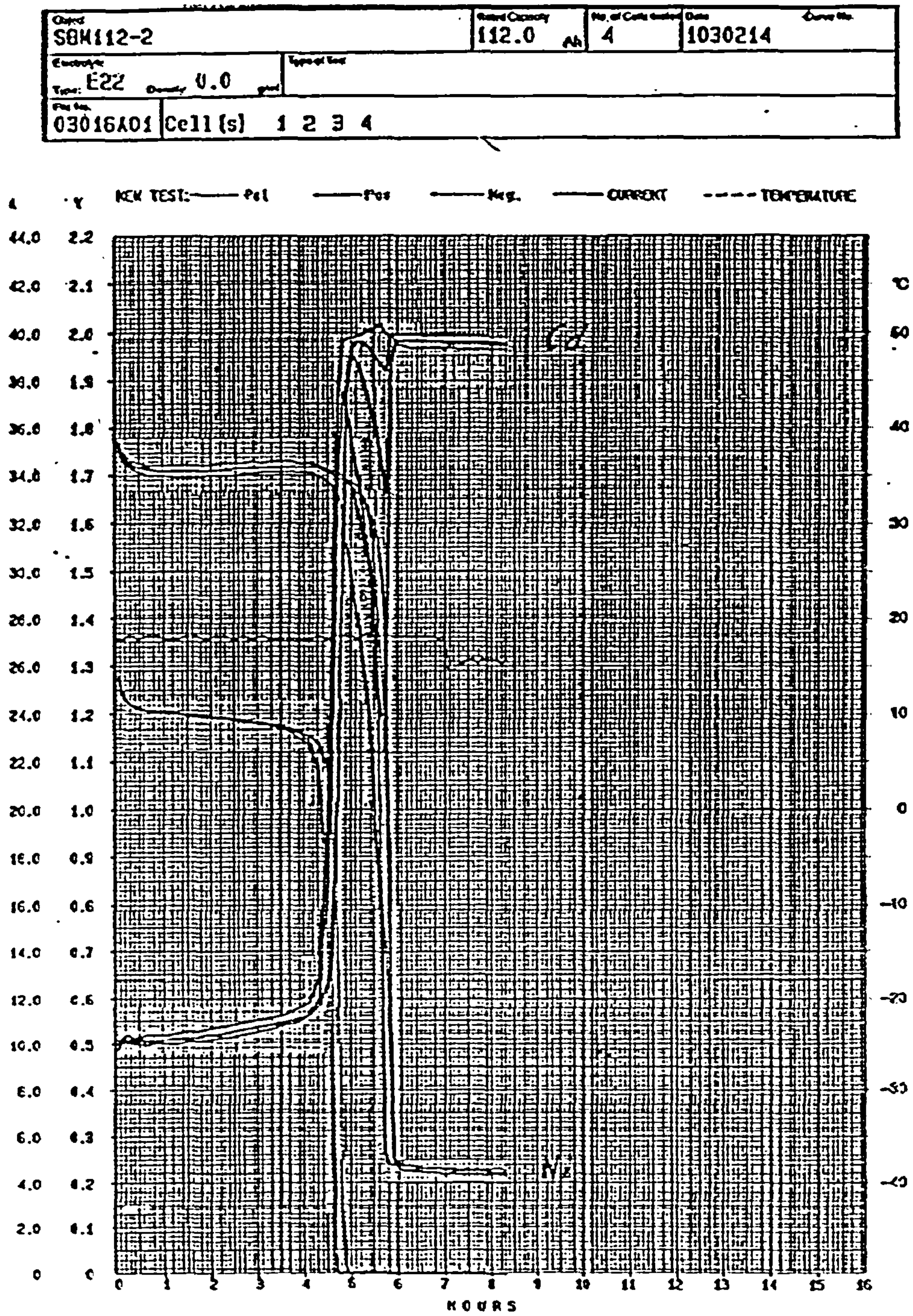
The workbook contains worksheets with IEEE 1115 calculations for each of the load profiles, with each calculation including the required 1.25 aging factor. There is also a summary sheet that shows the load profiles used in the sizing calculations, the required battery capacity, and the resulting margin for the SBM277 batteries.

The load profiles used in the calculations are simplified versions of the actual profiles. In each case, however, the profiles used fully envelope all actual loads.

Considering all possible load scenarios, the minimum margin available under the worst-case condition is 34% (i.e. the required capacity is 66% of the rated capacity of the SBM277). On this basis, it is Saft's view that these batteries may be safely operated with one low voltage cell without compromising the battery's ability to perform as specified.

Jim McDowall
February 28, 2003

Cell Reversal Profile (CELL_REV.PDF)
Reference Electrode Positive and Negative Plate Potentials During Cell Discharge



Legend:

______ Positive (Ni) – to - Reference Electrode Potential

______ Negative (Cd) – to - Reference Electrode Potential

______ Positive (Ni) – to - Negative Terminal Potential (negative values not shown)

Duke Energy - Catawba Station
Battery resizing project, assuming 1 cell reversed

1DGBA LOCA-BO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	178.61
1	11	10	28.67
11	12	1	97.87
12	20	8	27.87
20	61	41	26.31
61	120	59	25.75

Sizing Summary

Required Ah	Margin %
181.8	34%

1DGBA SBO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	78.85
1	20	19	31.00
20	22	2	82.54
22	30	8	33.81
30	60	30	20.12
60	61	1	72.16
61	239	178	20.64
239	240	1	54.27

Sizing Summary

Required Ah	Margin %
168.5	39%

1DGBB LOCA-BO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	177.37
1	11	10	26.19
11	12	1	95.15
12	20	8	25.15
20	61	41	23.57
61	120	59	23.01

Sizing Summary

Required Ah	Margin %
180.5	35%

1DGBB SBO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	76.28
1	20	19	28.41
20	22	2	79.96
22	30	8	31.22
30	60	30	17.54
60	61	1	69.58
61	239	178	18.05
239	240	1	54.27

Sizing Summary

Required Ah	Margin %
155.2	44%

2DGBA LOCA-BO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	178.47
1	11	10	29.57
11	12	1	99.57
12	20	8	29.57
20	61	41	28.01
61	120	59	27.45

Sizing Summary

Required Ah	Margin %
181.7	34%

2DGBA SBO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	78.52
1	20	19	30.62
20	22	2	82.22
22	30	8	33.48
30	60	30	19.80
60	61	1	71.84
61	239	178	20.31
239	240	1	54.27

Sizing Summary

Required Ah	Margin %
166.8	40%

2DGBB LOCA-BO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	177.47
1	11	10	26.29
11	12	1	95.25
12	20	8	25.25
20	61	41	23.67
61	120	59	23.11

Sizing Summary

Required Ah	Margin %
180.6	35%

2DGBB SBO

Load Profile

Start time (min)	End time (min)	Run time (min)	Current (A)
0	1	1	77.53
1	20	19	28.40
20	22	2	79.95
22	30	8	31.22
30	60	30	17.53
60	61	1	69.57
61	239	178	18.05
239	240	1	54.27

Sizing Summary

Required Ah	Margin %
155.3	44%

Project: Duke Energy / Catawba - 1DGBA LOCA-BO | Date: 1/30/2003 | Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F | Minimum Cell Voltage: 1.1484V | Cell Mfg: Saft | Cell Type: SBM | Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp-Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 178.61	A1-0= 178.61	M1= 1	t=M1= 1	0.761	1.07	145.44	***
					Sec 1	Total	145.44	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 178.61	A1-0= 178.61	M1= 1	t=M1+M2+M3= 12	1.355	1.06	256.54	0.00
2	A2= 28.67	A2-A1= -149.9	M2= 10	t=M2+M3= 11	1.322	1.06	0.00	210.11
3	A3= 97.87	A3-A2= 69.2	M3= 1	t=M3= 1	0.761	1.07	56.35	0.00
					Sec	Sub Total	312.89	210.11
					3	Total	102.77	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 178.61	A1-0= 178.61	M1= 1	t=M1+...M4= 20	1.583	1.06	299.70	0.00
2	A2= 28.67	A2-A1= -149.9	M2= 10	t=M2+M3+M4= 19	1.560	1.06	0.00	247.94
3	A3= 97.87	A3-A2= 69.2	M3= 1	t=M3+M4= 9	1.243	1.06	91.18	0.00
4	A4= 27.87	A4-A3= -70	M4= 8	t=M4= 8	1.202	1.06	0.00	89.19
					Sec	Sub Total	390.88	337.13
					4	Total	53.75	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1= 178.61	A1-0= 178.61	M1= 1	t=M1+...M5= 61	2.345	1.05	439.78	0.00
2	A2= 28.67	A2-A1= -149.9	M2= 10	t=M2+...M5= 60	2.328	1.05	0.00	366.51
3	A3= 97.87	A3-A2= 69.2	M3= 1	t=M3+M4+M5= 50	2.166	1.06	158.88	0.00
4	A4= 27.87	A4-A3= -70	M4= 8	t=M4+M5= 49	2.148	1.06	0.00	159.38
5	A5= 26.31	A5-A4= -1.56	M5= 41	t=M5= 41	2.018	1.06	0.00	3.34
					Sec	Sub Total	598.66	529.23
					5	Total	69.43	***
Section 6 - First Six Periods Only - if A7 is greater than A6, go to Section 7								
1	A1= 178.61	A1-0= 178.61	M1= 1	t=M1+...M6= 120	3.217	1.04	597.57	0.00
2	A2= 28.67	A2-A1= -149.9	M2= 10	t=M2+...M6= 119	3.202	1.04	0.00	499.31
3	A3= 97.87	A3-A2= 69.2	M3= 1	t=M3+...M6= 109	3.066	1.04	220.65	0.00
4	A4= 27.87	A4-A3= -70	M4= 8	t=M4+M5+M6= 103	3.054	1.04	0.00	222.33
5	A5= 26.31	A5-A4= -1.56	M5= 41	t=M5+M6= 100	2.946	1.04	0.00	4.78
6	A6= 25.75	A6-A5= -0.56	M6= 59	t=M6= 59	2.312	1.05	0.00	1.36
					Sec	Sub Total	818.23	727.78
					6	Total	90.44	***
Section 7 - First Seven Periods Only - if A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0.00	0.00
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0.00	0.00
7	A7=	A7-A6= 0	M7=	t=M7= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					7	Total	0.00	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0.00	***

Maximum Section Size (9) 145.44 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 145.44

US (12) 145.44 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 181.80

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Project: Duke Energy / Catawba - 1DGBA SBO | Date: 1/30/2003 | Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F | Minimum Cell Voltage: 1.1484V | Cell Mfg: Saft | Cell Type: SBM | Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 78.85	A1-0= 78.85	M1= 1	t=M1= 1	0.761	1.07	64.21	***
					Sec 1	Total	64.21	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 78.85	A1-0= 78.85	M1= 1	t=M1+M2+M3= 22	1.637	1.06	136.82	0.00
2	A2= 31.00	A2-A1= -47.85	M2= 19	t=M2+M3= 21	1.608	1.06	0.00	81.56
3	A3= 82.54	A3-A2= 51.54	M3= 2	t=M3= 2	0.870	1.07	47.98	0.00
					Sec	Sub Total	184.80	81.56
					3	Total	103.24	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 78.85	A1-0= 78.85	M1= 1	t=M1+...M4= 30	1.822	1.06	152.28	0.00
2	A2= 31.00	A2-A1= -47.85	M2= 19	t=M2+M3+M4= 29	1.803	1.06	0.00	91.45
3	A3= 82.54	A3-A2= 51.54	M3= 2	t=M3+M4= 10	1.282	1.06	70.04	0.00
4	A4= 33.81	A4-A3= -48.73	M4= 8	t=M4= 8	1.202	1.06	0.00	62.09
					Sec	Sub Total	222.32	153.54
					4	Total	68.79	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1=	A1-0= 0	M1=	t=M1+...M5= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M5= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+M4+M5= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+M5= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					5	Total	0.00	***
Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7								
1	A1= 78.85	A1-0= 78.85	M1= 1	t=M1+...M6= 61	2.345	1.05	194.15	0.00
2	A2= 31.00	A2-A1= -47.85	M2= 19	t=M2+...M6= 60	2.328	1.05	0.00	116.96
3	A3= 82.54	A3-A2= 51.54	M3= 2	t=M3+...M6= 41	2.018	1.06	110.25	0.00
4	A4= 33.81	A4-A3= -48.73	M4= 8	t=M4+M5+M6= 39	1.987	1.06	0.00	102.64
5	A5= 20.12	A5-A4= -13.69	M5= 30	t=M5+M6= 31	1.844	1.06	0.00	26.76
6	A6= 72.16	A6-A5= 52.04	M6= 1	t=M6= 1	0.761	1.07	42.37	0.00
					Sec	Sub Total	346.77	246.36
					6	Total	100.41	***
Section 7 - First Seven Periods Only - If A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0.00	0.00
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0.00	0.00
7	A7=	A7-A6= 0	M7=	t=M7= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					7	Total	0.00	***
Section 8 - First Eight Periods Only - If A9 is greater than A8, go to Section 9								
1	A1= 78.85	A1-0= 78.85	M1= 1	t=M1+...M8= 240	4.754	1.03	386.10	0.00
2	A2= 31.00	A2-A1= -47.85	M2= 19	t=M2+...M8= 239	4.740	1.03	0.00	233.61
3	A3= 82.54	A3-A2= 51.54	M3= 2	t=M3+...M8= 220	4.518	1.04	242.17	0.00
4	A4= 33.81	A4-A3= -48.73	M4= 8	t=M4+...M8= 218	4.490	1.04	0.00	227.55
5	A5= 20.12	A5-A4= -13.69	M5= 30	t=M5+...M8= 210	4.398	1.04	0.00	62.62
6	A6= 72.16	A6-A5= 52.04	M6= 1	t=M6+M7+M8= 180	4.044	1.04	218.87	0.00
7	A7= 20.64	A7-A6= -51.52	M7= 178	t=M7+M8= 179	4.031	1.04	0.00	215.98
8	A8= 54.27	A8-A7= 33.63	M8= 1	t=M8= 1	0.761	1.07	27.38	0.00
					Sec	Sub Total	874.52	739.76
					8	Total	134.76	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 134.76 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 134.76

US (12) 134.76 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 168.45

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Project: Duke Energy / Catawba - 1DGBB LOCA-BO | Date: 1/30/2003 | Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F | Minimum Cell Voltage: 1.1484V | Cell Mfg: Saft | Cell Type: SBM | Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 177.37	A1-0= 177.37	M1= 1	t=M1= 1	0.761	1.07	144.43	***
					Sec 1	Total	144.43	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 177.37	A1-0= 177.37	M1= 1	t=M1+M2+M3= 12	1.355	1.06	254.76	0.00
2	A2= 26.19	A2-A1= -151.2	M2= 10	t=M2+M3= 11	1.322	1.06	0.00	211.85
3	A3= 95.15	A3-A2= 68.96	M3= 1	t=M3= 1	0.761	1.07	56.15	0.00
					Sec	Sub Total	310.91	211.85
					3	Total	99.06	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 177.37	A1-0= 177.37	M1= 1	t=M1+...M4= 20	1.583	1.06	297.62	0.00
2	A2= 26.19	A2-A1= -151.2	M2= 10	t=M2+M3+M4= 19	1.560	1.06	0.00	249.99
3	A3= 95.15	A3-A2= 68.96	M3= 1	t=M3+M4= 9	1.243	1.06	90.86	0.00
4	A4= 25.15	A4-A3= -70	M4= 8	t=M4= 8	1.202	1.06	0.00	89.19
					Sec	Sub Total	388.48	339.18
					4	Total	49.30	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1= 177.37	A1-0= 177.37	M1= 1	t=M1+...M5= 61	2.345	1.05	436.73	0.00
2	A2= 26.19	A2-A1= -151.2	M2= 10	t=M2+...M5= 60	2.328	1.05	0.00	369.54
3	A3= 95.15	A3-A2= 68.96	M3= 1	t=M3+M4+M5= 50	2.166	1.06	158.33	0.00
4	A4= 25.15	A4-A3= -70	M4= 8	t=M4+M5= 49	2.148	1.06	0.00	159.38
5	A5= 23.57	A5-A4= -1.58	M5= 41	t=M5= 41	2.018	1.06	0.00	3.38
					Sec	Sub Total	595.06	532.31
					5	Total	62.75	***
Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7								
1	A1= 177.37	A1-0= 177.37	M1= 1	t=M1+...M6= 120	3.217	1.04	593.42	0.00
2	A2= 26.19	A2-A1= -151.2	M2= 10	t=M2+...M6= 119	3.202	1.04	0.00	503.44
3	A3= 95.15	A3-A2= 68.96	M3= 1	t=M3+...M6= 109	3.066	1.04	219.89	0.00
4	A4= 25.15	A4-A3= -70	M4= 8	t=M4+M5+M6= 108	3.054	1.04	0.00	222.33
5	A5= 23.57	A5-A4= -1.58	M5= 41	t=M5+M6= 100	2.946	1.04	0.00	4.84
6	A6= 23.01	A6-A5= -0.56	M6= 59	t=M6= 59	2.312	1.05	0.00	1.36
					Sec	Sub Total	813.31	731.97
					6	Total	81.34	***
Section 7 - First Seven Periods Only - If A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0	0
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0	0
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0	0
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0	0
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0	0
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0	0
7	A7=	A7-A6= 0	M7=	t=M7= 0			0	0
					Sec	Sub Total	0	0
					7	Total	0	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 144.43 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 144.43

US (12) 144.43 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 180.54

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Project: Duke Energy / Catawba - 1DGBB SBO | Date: 1/30/2003 | Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F | Minimum Cell Voltage: 1.1484V | Cell Mfg: Saft | Cell Type: SBM | Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 76.28	A1-0= 76.28	M1= 1	t=M1= 1	0.761	1.07	62.11	***
					Sec 1	Total	62.11	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 76.28	A1-0= 76.28	M1= 1	t=M1+M2+M3= 22	1.637	1.06	132.36	0.00
2	A2= 28.41	A2-A1= -47.87	M2= 19	t=M2+M3= 21	1.608	1.06	0.00	81.59
3	A3= 79.96	A3-A2= 51.55	M3= 2	t=M3= 2	0.870	1.07	47.99	0.00
					Sec	Sub Total	180.35	81.59
					3	Total	98.76	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 76.28	A1-0= 76.28	M1= 1	t=M1+...M4= 30	1.822	1.06	147.32	0.00
2	A2= 28.41	A2-A1= -47.87	M2= 19	t=M2+M3+M4= 29	1.803	1.06	0.00	91.49
3	A3= 79.96	A3-A2= 51.55	M3= 2	t=M3+M4= 10	1.282	1.06	70.05	0.00
4	A4= 31.22	A4-A3= -48.74	M4= 8	t=M4= 8	1.202	1.06	0.00	62.10
					Sec	Sub Total	217.37	153.59
					4	Total	63.78	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1=	A1-0= 0	M1=	t=M1+...M5= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M5= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+M4+M5= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+M5= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					5	Total	0.00	***
Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7								
1	A1= 76.28	A1-0= 76.28	M1= 1	t=M1+...M6= 61	2.345	1.05	187.82	0.00
2	A2= 28.41	A2-A1= -47.87	M2= 19	t=M2+...M6= 60	2.328	1.05	0.00	117.01
3	A3= 79.96	A3-A2= 51.55	M3= 2	t=M3+...M6= 41	2.018	1.06	110.27	0.00
4	A4= 31.22	A4-A3= -48.74	M4= 8	t=M4+M5+M6= 39	1.987	1.06	0.00	102.66
5	A5= 17.54	A5-A4= -13.68	M5= 30	t=M5+M6= 31	1.844	1.06	0.00	26.74
6	A6= 69.58	A6-A5= 52.04	M6= 1	t=M6= 1	0.761	1.07	42.37	0.00
					Sec	Sub Total	340.46	246.41
					6	Total	94.05	***
Section 7 - First Seven Periods Only - If A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0.00	0.00
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0.00	0.00
7	A7=	A7-A6= 0	M7=	t=M7= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					7	Total	0.00	***
Section 8 - First Eight Periods Only - If A9 is greater than A8, go to Section 9								
1	A1= 76.28	A1-0= 76.28	M1= 1	t=M1+...M8= 240	4.754	1.03	373.51	0.00
2	A2= 28.41	A2-A1= -47.87	M2= 19	t=M2+...M8= 239	4.740	1.03	0.00	233.71
3	A3= 79.96	A3-A2= 51.55	M3= 2	t=M3+...M8= 220	4.518	1.04	242.22	0.00
4	A4= 31.22	A4-A3= -48.74	M4= 8	t=M4+...M8= 218	4.490	1.04	0.00	227.60
5	A5= 17.54	A5-A4= -13.68	M5= 30	t=M5+...M8= 210	4.398	1.04	0.00	62.57
6	A6= 69.58	A6-A5= 52.04	M6= 1	t=M6+M7+M8= 180	4.044	1.04	218.87	0.00
7	A7= 18.05	A7-A6= -51.53	M7= 178	t=M7+M8= 179	4.031	1.04	0.00	216.03
8	A8= 54.27	A8-A7= 36.22	M8= 1	t=M8= 1	0.761	1.07	29.49	0.00
					Sec	Sub Total	864.09	739.90
					8	Total	124.19	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 124.19 + Random Section Size (10) ______ = Uncorrected Size (US) (11) 124.19

US (12) 124.19 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 155.24

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ______ Ampere Hours. Therefore cell (17) ______ is required.

Project: Duke Energy / Catawba - 2DGBA LOCA-BO Date: 1/30/2003 Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F Minimum Cell Voltage: 1.1484V Cell Mfg: Saft Cell Type: SBM Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 178.47	A1-0= 178.47	M1= 1	t=M1= 1	0.761	1.07	145.32	***
					Sec 1	Total	145.32	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 178.47	A1-0= 178.47	M1= 1	t=M1+M2+M3= 12	1.355	1.06	256.34	0.00
2	A2= 29.57	A2-A1= -148.9	M2= 10	t=M2+M3= 11	1.322	1.06	0.00	208.66
3	A3= 99.57	A3-A2= 70	M3= 1	t=M3= 1	0.761	1.07	57.00	0.00
					Sec	Sub Total	313.34	208.66
					3	Total	104.68	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 178.47	A1-0= 178.47	M1= 1	t=M1+...M4= 20	1.583	1.06	299.47	0.00
2	A2= 29.57	A2-A1= -148.9	M2= 10	t=M2+M3+M4= 19	1.560	1.06	0.00	246.22
3	A3= 99.57	A3-A2= 70	M3= 1	t=M3+M4= 9	1.243	1.06	92.23	0.00
4	A4= 29.57	A4-A3= -70	M4= 8	t=M4= 8	1.202	1.06	0.00	89.19
					Sec	Sub Total	391.70	335.41
					4	Total	56.29	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1= 178.47	A1-0= 178.47	M1= 1	t=M1+...M5= 61	2.345	1.05	439.44	0.00
2	A2= 29.57	A2-A1= -148.9	M2= 10	t=M2+...M5= 60	2.328	1.05	0.00	363.97
3	A3= 99.57	A3-A2= 70	M3= 1	t=M3+M4+M5= 50	2.166	1.06	160.72	0.00
4	A4= 29.57	A4-A3= -70	M4= 8	t=M4+M5= 49	2.148	1.06	0.00	159.38
5	A5= 28.01	A5-A4= -1.56	M5= 41	t=M5= 41	2.018	1.06	0.00	3.34
					Sec	Sub Total	600.15	526.69
					5	Total	73.47	***
Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7								
1	A1= 178.47	A1-0= 178.47	M1= 1	t=M1+...M6= 120	3.217	1.04	597.10	0.00
2	A2= 29.57	A2-A1= -148.9	M2= 10	t=M2+...M6= 119	3.202	1.04	0.00	495.85
3	A3= 99.57	A3-A2= 70	M3= 1	t=M3+...M6= 109	3.066	1.04	223.20	0.00
4	A4= 29.57	A4-A3= -70	M4= 8	t=M4+M5+M6= 108	3.054	1.04	0.00	222.33
5	A5= 28.01	A5-A4= -1.56	M5= 41	t=M5+M6= 100	2.946	1.04	0.00	4.78
6	A6= 27.45	A6-A5= -0.56	M6= 59	t=M6= 59	2.312	1.05	0.00	1.36
					Sec	Sub Total	820.31	724.32
					6	Total	95.99	***
Section 7 - First Seven Periods Only - If A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0	0
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0	0
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0	0
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0	0
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0	0
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0	0
7	A7=	A7-A6= 0	M7=	t=M7= 0			0	0
					Sec	Sub Total	0	0
					7	Total	0	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 145.32 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 145.32

US (12) 145.32 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 181.65

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Project: Duke Energy / Catawba - 2DGBA SBO　　Date: 1/30/2003　　Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F　　Minimum Cell Voltage: 1.1484V　　Cell Mfg: Saft　　Cell Type: SBM　　Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - If A2 is greater than A1, go to Section 2								
1	A1= 78.52	A1-0= 78.52	M1= 1	t=M1= 1	0.761	1.07	63.94	***
					Sec 1	Total	63.94	***
Section 2 - First Two Periods Only - If A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - If A4 is greater than A3, go to Section 4								
1	A1= 78.52	A1-0= 78.52	M1= 1	t=M1+M2+M3= 22	1.637	1.06	136.25	0.00
2	A2= 30.62	A2-A1= -47.9	M2= 19	t=M2+M3= 21	1.608	1.06	0.00	81.64
3	A3= 82.22	A3-A2= 51.6	M3= 2	t=M3= 2	0.870	1.07	48.03	0.00
					Sec	Sub Total	184.28	81.64
					3	Total	102.64	***
Section 4 - First Four Periods Only - If A5 is greater than A4, go to Section 5								
1	A1= 78.52	A1-0= 78.52	M1= 1	t=M1+...M4= 30	1.822	1.06	151.65	0.00
2	A2= 30.62	A2-A1= -47.9	M2= 19	t=M2+M3+M4= 29	1.803	1.06	0.00	91.55
3	A3= 82.22	A3-A2= 51.6	M3= 2	t=M3+M4= 10	1.282	1.06	70.12	0.00
4	A4= 33.48	A4-A3= -48.74	M4= 8	t=M4= 8	1.202	1.06	0.00	62.10
					Sec	Sub Total	221.77	153.65
					4	Total	68.12	***
Section 5 - First Five Periods Only - If A6 is greater than A5, go to Section 6								
1	A1=	A1-0= 0	M1=	t=M1+...M5= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M5= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+M4+M5= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+M5= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					5	Total	0.00	***
Section 6 - First Six Periods Only - If A7 is greater than A6, go to Section 7								
1	A1= 78.52	A1-0= 78.52	M1= 1	t=M1+...M6= 61	2.345	1.05	193.34	0.00
2	A2= 30.62	A2-A1= -47.9	M2= 19	t=M2+...M6= 60	2.328	1.05	0.00	117.09
3	A3= 82.22	A3-A2= 51.6	M3= 2	t=M3+...M6= 41	2.018	1.06	110.38	0.00
4	A4= 33.48	A4-A3= -48.74	M4= 8	t=M4+M5+M6= 39	1.987	1.06	0.00	102.66
5	A5= 19.80	A5-A4= -13.68	M5= 30	t=M5+M6= 31	1.844	1.06	0.00	26.74
6	A6= 71.84	A6-A5= 52.04	M6= 1	t=M6= 1	0.761	1.07	42.37	0.00
					Sec	Sub Total	346.09	246.48
					6	Total	99.60	***
Section 7 - First Seven Periods Only - If A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0.00	0.00
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0.00	0.00
7	A7=	A7-A6= 0	M7=	t=M7= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					7	Total	0.00	***
Section 8 - First Eight Periods Only - If A9 is greater than A8, go to Section 9								
1	A1= 78.52	A1-0= 78.52	M1= 1	t=M1+...M8= 240	4.754	1.03	384.48	0.00
2	A2= 30.62	A2-A1= -47.9	M2= 19	t=M2+...M8= 239	4.740	1.03	0.00	233.86
3	A3= 82.22	A3-A2= 51.6	M3= 2	t=M3+...M8= 220	4.518	1.04	242.45	0.00
4	A4= 33.48	A4-A3= -48.74	M4= 8	t=M4+...M8= 218	4.490	1.04	0.00	227.60
5	A5= 19.80	A5-A4= -13.68	M5= 30	t=M5+...M8= 210	4.398	1.04	0.00	62.57
6	A6= 71.84	A6-A5= 52.04	M6= 1	t=M6+M7+M8= 180	4.044	1.04	218.87	0.00
7	A7= 20.31	A7-A6= -51.53	M7= 178	t=M7+M8= 179	4.031	1.04	0.00	216.03
8	A8= 54.27	A8-A7= 33.96	M8= 1	t=M8= 1	0.761	1.07	27.65	0.00
					Sec	Sub Total	873.46	740.05
					8	Total	133.41	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 133.41 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 133.41

US (12) 133.41 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 166.76

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Project: Duke Energy / Catawba - 2DGBB LOCA-BO Date: 1/30/2003 Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F Minimum Cell Voltage: 1.1484V Cell Mfg: Saft Cell Type: SBM Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at 1 Min Rate *(Kt)*	(7) Temperature Derating Factor for 1 Min *(Tt)*	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - if A2 is greater than A1, go to Section 2								
1	A1= 177.47	A1-0= 177.47	M1= 1	t=M1= 1	0.761	1.07	144.51	***
					Sec 1	Total	144.51	***
Section 2 - First Two Periods Only - if A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - if A4 is greater than A3, go to Section 4								
1	A1= 177.47	A1-0= 177.47	M1= 1	t=M1+M2+M3= 12	1.355	1.06	254.90	0.00
2	A2= 26.29	A2-A1= -151.2	M2= 10	t=M2+M3= 11	1.322	1.06	0.00	211.85
3	A3= 95.25	A3-A2= 68.96	M3= 1	t=M3= 1	0.761	1.07	56.15	0.00
					Sec	Sub Total	311.05	211.85
					3	Total	99.20	***
Section 4 - First Four Periods Only - if A5 is greater than A4, go to Section 5								
1	A1= 177.47	A1-0= 177.47	M1= 1	t=M1+...M4= 20	1.583	1.06	297.79	0.00
2	A2= 26.29	A2-A1= -151.2	M2= 10	t=M2+M3+M4= 19	1.560	1.06	0.00	249.99
3	A3= 95.25	A3-A2= 68.96	M3= 1	t=M3+M4= 9	1.243	1.06	90.86	0.00
4	A4= 25.25	A4-A3= -70	M4= 8	t=M4= 8	1.202	1.06	0.00	89.19
					Sec	Sub Total	388.65	339.18
					4	Total	49.47	***
Section 5 - First Five Periods Only - if A6 is greater than A5, go to Section 6								
1	A1= 177.47	A1-0= 177.47	M1= 1	t=M1+...M5= 61	2.345	1.05	436.98	0.00
2	A2= 26.29	A2-A1= -151.2	M2= 10	t=M2+...M5= 60	2.328	1.05	0.00	369.54
3	A3= 95.25	A3-A2= 68.96	M3= 1	t=M3+M4+M5= 50	2.166	1.06	158.33	0.00
4	A4= 25.25	A4-A3= -70	M4= 8	t=M4+M5= 49	2.148	1.06	0.00	159.38
5	A5= 23.67	A5-A4= -1.58	M5= 41	t=M5= 41	2.018	1.06	0.00	3.38
					Sec	Sub Total	595.30	532.31
					5	Total	63.00	***
Section 6 - First Six Periods Only - if A7 is greater than A6, go to Section 7								
1	A1= 177.47	A1-0= 177.47	M1= 1	t=M1+...M6= 120	3.217	1.04	593.76	0.00
2	A2= 26.29	A2-A1= -151.2	M2= 10	t=M2+...M6= 119	3.202	1.04	0.00	503.44
3	A3= 95.25	A3-A2= 68.96	M3= 1	t=M3+...M6= 109	3.066	1.04	219.89	0.00
4	A4= 25.25	A4-A3= -70	M4= 8	t=M4+M5+M6= 108	3.054	1.04	0.00	222.33
5	A5= 23.67	A5-A4= -1.58	M5= 41	t=M5+M6= 100	2.946	1.04	0.00	4.84
6	A6= 23.11	A6-A5= -0.56	M6= 59	t=M6= 59	2.312	1.05	0.00	1.36
					Sec	Sub Total	813.65	731.97
					6	Total	81.67	***
Section 7 - First Seven Periods Only - if A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 0			0	0
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 0			0	0
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 0			0	0
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 0			0	0
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 0			0	0
6	A6=	A6-A5= 0	M6=	t=M6+M7= 0			0	0
7	A7=	A7-A6= 0	M7=	t=M7= 0			0	0
					Sec	Sub Total	0	0
					7	Total	0	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 144.51 + Random Section Size (10) ______ = Uncorrected Size (US) (11) 144.51

US (12) 144.51 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 180.64

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ______ Ampere Hours. Therefore cell (17) ______ is required.

Project: Duke Energy / Catawba - 20GBB SBO　　　Date: 1/30/2003　　　Page: 1 of 1

Lowest Expected Electrolyte Temp: 60 °F　　Minimum Cell Voltage: 1.1484V　Cell Mfg: Saft　　Cell Type: SBM　　Sized By: JMcD

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration or Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity Rating Factor at t Min Rate (Kt)	(7) Temperature Derating Factor for t Min (Tt)	(8) Required Section Size (3) x (6) x (7) = Rated Amp Hrs Pos. Values	Neg. Values
Section 1 - First Period Only - if A2 is greater than A1, go to Section 2								
1	A1= 77.53	A1-0= 77.53	M1= 1	t=M1= 1	0.761	1.07	63.13	***
					Sec 1	Total	63.13	***
Section 2 - First Two Periods Only - if A3 is greater than A2, go to Section 3								
1	A1=	A1-0= 0	M1=	t=M1+M2= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					2	Total	0.00	***
Section 3 - First Three Periods Only - if A4 is greater than A3, go to Section 4								
1	A1= 77.53	A1-0= 77.53	M1= 1	t=M1+M2+M3= 22	1.637	1.06	134.53	0.00
2	A2= 28.40	A2-A1= -49.13	M2= 19	t=M2+M3= 21	1.608	1.06	0.00	83.74
3	A3= 79.95	A3-A2= 51.55	M3= 2	t=M3= 2	0.870	1.07	47.99	0.00
					Sec	Sub Total	182.52	83.74
					3	Total	98.78	***
Section 4 - First Four Periods Only - if A5 is greater than A4, go to Section 5								
1	A1= 77.53	A1-0= 77.53	M1= 1	t=M1+...M4= 30	1.822	1.06	149.74	0.00
2	A2= 28.40	A2-A1= -49.13	M2= 19	t=M2+M3+M4= 29	1.803	1.06	0.00	93.90
3	A3= 79.95	A3-A2= 51.55	M3= 2	t=M3+M4= 10	1.282	1.06	70.05	0.00
4	A4= 31.22	A4-A3= -48.73	M4= 8	t=M4= 8	1.202	1.06	0.00	62.09
					Sec	Sub Total	219.79	155.98
					4	Total	63.80	***
Section 5 - First Five Periods Only - if A6 is greater than A5, go to Section 6								
1	A1=	A1-0= 0	M1=	t=M1+...M5= 0			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M5= 0			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+M4+M5= 0			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+M5= 0			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					5	Total	0.00	***
Section 6 - First Six Periods Only - if A7 is greater than A6, go to Section 7								
1	A1= 77.53	A1-0= 77.53	M1= 1	t=M1+...M6= #REF!	2.345	1.05	190.90	0.00
2	A2= 28.40	A2-A1= -49.13	M2= 19	t=M2+...M6= #REF!	2.328	1.05	0.00	120.09
3	A3= 79.95	A3-A2= 51.55	M3= 2	t=M3+...M6= #REF!	2.018	1.06	110.27	0.00
4	A4= 31.22	A4-A3= -48.73	M4= 8	t=M4+M5+M6= #REF!	1.987	1.06	0.00	102.64
5	A5= 17.53	A5-A4= -13.69	M5= 30	t=M5+M6= #REF!	1.844	1.06	0.00	26.76
6	A6= 69.57	A6-A5= 52.04	M6= 1	t=M6= #REF!	0.761	1.07	42.37	0.00
					Sec	Sub Total	343.54	249.49
					6	Total	94.05	***
Section 7 - First Seven Periods Only - if A8 is greater than A7, go to Section 8								
1	A1=	A1-0= 0	M1=	t=M1+...M7= 61			0.00	0.00
2	A2=	A2-A1= 0	M2=	t=M2+...M7= 60			0.00	0.00
3	A3=	A3-A2= 0	M3=	t=M3+...M7= 41			0.00	0.00
4	A4=	A4-A3= 0	M4=	t=M4+...M7= 39			0.00	0.00
5	A5=	A5-A4= 0	M5=	t=M5+M6+M7= 31			0.00	0.00
6	A6=	A6-A5= 0	M6=	t=M6+M7= 1			0.00	0.00
7	A7=	A7-A6= 0	M7=	t=M7= 0			0.00	0.00
					Sec	Sub Total	0.00	0.00
					7	Total	0.00	***
Section 8 - First Eight Periods Only - if A9 is greater than A8, go to Section 9								
1	A1= 77.53	A1-0= 77.53	M1= 1	t=M1+...M8= 240	4.754	1.03	379.63	0.00
2	A2= 28.40	A2-A1= -49.13	M2= 19	t=M2+...M8= 239	4.740	1.03	0.00	239.86
3	A3= 79.95	A3-A2= 51.55	M3= 2	t=M3+...M8= 220	4.518	1.04	242.22	0.00
4	A4= 31.22	A4-A3= -48.73	M4= 8	t=M4+...M8= 218	4.490	1.04	0.00	227.55
5	A5= 17.53	A5-A4= -13.69	M5= 30	t=M5+...M8= 210	4.398	1.04	0.00	62.62
6	A6= 69.57	A6-A5= 52.04	M6= 1	t=M6+M7+M8= 180	4.044	1.04	218.87	0.00
7	A7= 18.05	A7-A6= -51.52	M7= 178	t=M7+M8= 179	4.031	1.04	0.00	215.98
8	A8= 54.27	A8-A7= 36.22	M8= 1	t=M8= 1	0.761	1.07	29.49	0.00
					Sec	Sub Total	870.21	746.01
					8	Total	124.20	***
Random Equipment Load Only (if needed)								
R	AR=	AR-0= 0	MR=	t=MR= 0			0	***

Maximum Section Size (9) 124.20 + Random Section Size (10) ________ = Uncorrected Size (US) (11) 124.20

US (12) 124.20 x Design Margin (13) 1.00 x Aging Factor (14) 1.25 = (15) 155.25

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) ________ Ampere Hours. Therefore cell (17) ________ is required.

Sizing factors for SBM cells discharging to 1.1484V/cell at 60°F

Time (min)	Kt	Tt
1	0.761	1.07
2	0.870	1.07
8	1.202	1.06
9	1.243	1.06
10	1.282	1.06
11	1.322	1.06
12	1.355	1.06
19	1.560	1.06
20	1.583	1.06
21	1.608	1.06
22	1.637	1.06
29	1.803	1.06
30	1.822	1.06
31	1.844	1.06
39	1.987	1.06
41	2.018	1.06
49	2.148	1.06
50	2.166	1.06
59	2.312	1.05
60	2.328	1.05
61	2.345	1.05
100	2.946	1.04
108	3.054	1.04
109	3.066	1.04
119	3.202	1.04
120	3.217	1.04
179	4.031	1.04
180	4.044	1.04
210	4.398	1.04
218	4.490	1.04
220	4.518	1.04
239	4.740	1.03
240	4.754	1.03