Batteries

1. General

This addendum is issued to change and/or supplement the information contained in Bellcore Practice BR 790-100-655, Batteries. This is a merged practice (MP), and provides standards for SBC.

2. Battery Types

2.1 Current battery technologies approved for use by SBC are either "flooded" lead acid type, Nickel Cadmium (NiCad), Lithium Metal Polymer (LMP) or valve regulated lead acid (VRLA) type. Refer to the Approved Product List (APL) for specific applications. Product Approval Notices and associated application drawings (SBC-P-053XX-E) will provide for any additional battery technology that may be approved in the immediate future.

2.2 In the scope of battery technology, VRLA is considered the least desirable technology currently approved by SBC. Even though limited applications may still exist that necessitate VRLA products, the use of this technology in going forward applications shall be avoided.

2.3 Flooded cells shall be used in all Central Office applications, unless they cannot be accommodated due to floor space requirements. Flooded cells are further described as rectangular or round cells. The rectangular cells approved for use in the company have an expected life of 20 or more years when maintained at an optimum ambient temperature of 77°F. Round cells have an expected life of 40 years or more.

2.4 The use of NiCad batteries in small Central Office applications is considered acceptable assuming the application can accommodate the voltage differences. The NiCad's provide an acceptable alternative to flooded lead acid batteries where limited floor space and ampacity demands are limited. When used, NiCad's shall not be mixed with any other battery technology within the same power plant.

2.5 NiCad, LMP and VRLA batteries are primarily used in Remote Terminal (RT) applications where it is not practical to use traditional flooded cells, either due to space requirements or maintenance requirements.

Battery Technology	Estimated Life Expectancy at 77F	Approximate Temperature Ranges
LMP	27 years	-40F to +149F
NiCad	20 years	-4F to +104F
VRLA	2-10 years	60F to 120F

2.6 VRLA batteries are subject to thermal runaway. An increase in charge current, such as that caused by a shorted cell, or a high ambient temperature may lead to an increase in battery temperature. The battery cannot dissipate the additional internal heat. The temperature rise causes an increase in current (if a constant voltage charger is used), and the increase in current leads to further increase in temperature until the battery enters thermal runaway.

3. Sizing Battery Plants

3.1 Minimum Volts Per Cell (MVPC)

3.1.1 The MVPC is the minimum voltage each cell may reduce to while in discharge and still maintain satisfactory operation of all equipment served by that plant. MVPC is calculated with the following equation;

$$\text{MVPC} = \frac{\text{(Equipment Volt)} + \text{(Primary Drop)} + \text{(Charge/Discharge Drop)}}{\text{Total Number of Cells in a Battery String}}$$

Equipment Volt:	Equipment minimum voltage drop
Primary Drop:	Primary distribution voltage drop
Charge/Discharge Drop:	Charge/Discharge Network voltage drop consisting of the power system infrastructure; including shunt, bus bars, power cable, battery cable and battery interconnects.

3.2 Operating Voltage Limits

Going forward the specific MVPC that shall be used is as follows:

- Flooded lead acid cells shall use a MVPC of 1.86 volts per cell.
- CO Nickel Cadmium (NiCad) cells shall use MVPC of 1.17vDC volts per cell.
- RT applications with Nickel Cadmium (NiCad) cells shall use 1.10 volts per cell.
- RT applications with Valve Regulated Lead Acid (VRLA) cells shall use 1.75 volts per cell.
- RT applications with Lithium Metal Polymer (LMP) cells shall use 2.33 volts per cell.

The specific float voltage in various situations shall be as follows:

- Flooded lead acid cells shall use 2.20 volts per cell with a 24-cell string floating at 52.80 V.
- CO and RT applications with Nickel Cadmium (NiCad) cells shall use 1.43 volts per cell with a 38-cell string floating at 54.4 V .

- RT applications with VRLA cells shall use 2.25 volts per cell based on a 24-cell string floating at 54 V.
- RT applications with LMP cells shall use 3.02 volts per cell based on a 18-cell 48V block floating at 54.40 vDC.

3.2.1 The SBC Power Equipment Engineer must look at cable size carefully before changing a plant previously engineered with a MVPC other than 1.86. A higher MVPC causes the battery capacity to decrease and allowed for smaller gauge cables to be used. The cabling in place may not be adequate for the 1.86 MVPC. The present MVPC, other than 1.86 may be retained when it is not economically feasible to upgrade the cable capacity.

3.2.2 When an MVPC other than 1.86 has been determined to be necessary, the SBC Power Equipment Engineer shall make the appropriate notation currently in practice (stenciling the power board, mechanized power plant inventory system, equipment drawings, etc) for SBC.

3.3 **Battery Reserve Time**

3.3.1 The SBC LEC Power Equipment Engineer shall provision for battery reserve times based upon whether the office has a stationary stand-by engine/alternator set or is equipped for the use of a portable engine/alternator. Site-specific circumstances shall also be taken into considerations when determining the appropriate reserve time. Items such as the reliability of commercial power and customer base may motivate reserves higher than the minimum standards stated within this document. This additional battery allowance may impact rectifier re-charge capacity.

3.3.2 In all central office applications with a stationary Engine/Alternator set, the SBC Power Equipment Engineer shall provision a minimum of 4 hours battery reserve, unless greater values are dictated by local/state agencies. This will be based upon Power Fail Loads (PFL) and the constant current drain tables provided by the battery manufacturer. These tables are also imbedded in the PowerPro database.

3.3.3 In central office applications without a stationary Engine/Alternator, the SBC LEC Power Equipment Engineer shall provision battery reserve based upon the necessary travel time for the location. A minimum of 8 hours may be acceptable; however, an average of 12 hours is recommended, and a maximum of 24 hours is allowed. This requirement calls for a range of this nature as site specifics vary so drastically over the 13-state region. An analysis that balances expense and reliability must be determined by the SBC LEC Power Equipment Engineer based upon the following criteria:

- Reliability of commercial power
- Customer base
- Technical support availability
- Location of office
- Engine acquisition time
- Availability of office floor space

3.3.4 In RT applications, the SBC power equipment engineer shall provision sites with 8 hours of battery reserve. Refer to BSP 790-100-652 section 2 for more detailed information.

3.3.5 Battery reserve requirements for Uninterruptible Power Supply (UPS) units are outlined in BSP 790-100-660MP, AC Power.

4. Lead Acid Battery Aging Characteristics

4.1 A battery cell should be replaced when it reaches 80% of its rated capacity. The method of determining this is a capacity discharge test. This test is quite time consuming and expensive, it is rarely economically justified. The SBC LEC Power Equipment Engineer may use a number of other methods to estimate the condition of the cells. The recommended methods are as follows:

- Physical inspection: The battery itself will show physical signs of aging. Indicators such as the appearance of crystals, drastically deformed plates, and battery post/jar seal deformation are signs that the cell has lost some reliability and integrity making it a candidate for replacement.
- Monitoring Environment: The ambient temperature of the battery room shall be monitored to ensure proper environmental conditions that prevent premature aging of cells. Batteries shall be engineered based on an optimum temperature of 77F. Power COE's shall coordinate with the SBC CRE-Property Management using a Building Work Request (BWR) to insure this optimization can be achieved. Deviation from a 77F temperature for an extended period of time will change battery life expectations.
- Resistance and/or Conductance Test: This method is a valid means of indicating the capacity of lead acid battery cells. Power Maintenance Engineers (METS) or Network Operations will run these tests. Battery records should be maintained indicating the initial test results at the time of installation and subsequent test results. Resistance/Conductance testing of flooded battery technology shall be used as an indicator that further testing may be required. Flooded battery replacement purely based on resistance/conductance testing is still considered insufficient data under current flooded battery warranty contracts.

4.2 Central Office battery cell de-ration depends on the items outlined in paragraph 4.1 of this document, the age of the cells and the technology deployed. In reference to the de-rating of battery cells for the purpose of capacity management, the cells shall be evaluated using the following criteria:

- Technology deployed – Only rectangular flooded lead acid batteries shall be de-rated for capacity management. Round Cells shall be rated at full capacity for the full life cycle of the cell.
- Inspection Methods – The three methods of inspection above (in 4.1) are to be used when evaluating cells for capacity management as well as replacement. When being used for capacity management, the results are to be evaluated by the SBC power equipment engineer, and the appropriate de-ration applied based upon the physical condition of the cells.
- Age of Cell – When rectangular flooded lead acid cells are in place they shall be de-rated by 10% when they reach 15 years of age. That 10% is in addition to any de-ration determined by the inspection methods outlined in above.
- The power equipment engineer shall utilize the PowerPro® database to record and acknowledge this de-rating factor on a case-by-case basis by re-calculating the capacity.

4.3 The ideal ambient temperature for either flooded lead acid, NiCad, or VRLA battery cells is 77° F. For flooded &VRLA cells, each 15° F increase in ambient temperature doubles the rate at which the battery ages. The longer the period of exposure to the higher temperatures, the greater the damage. Also, the damage done to the cells by heat exposure is permanent. When the ambient temperature is lower than the ideal 77° F, the battery aging is reduced; however, the battery capacity is also reduced. The loss in battery capacity from the lower ambient temperature is not permanent. The capacity will restore when the temperature rises, however sustained and constant lower temperatures will affect capacity values if a power failure were to occur. Assuming the power equipment engineer follows the listed methods of engineering batteries, including aging, power factors and growth potential sizing as defined in the Power - Infrastructure Deployment Guideline (IDG), the additional compensation for lower temperatures shall not be allowed. [1]. Refer to chart in paragraph 2.5 for temperature ranges.

4.4 Temperature compensation modules are required when using VRLA battery cells. They shall be alarmed for high temperature. NiCad and LMP battery cells **shall not** be temperature compensated, and temperature alarming is not required.

4.5 Each string of VRLA batteries shall be provided with a quick disconnect arrangement. This has been determined to be necessary to ensure the safety of those working with batteries in a confined space. The disconnect may be a quick-connect plug, a circuit breaker, or other approved arrangements.

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[1] IEEE STE. 450-1995 par. 6.6 Service Tests states; *If the battery was sized in accordance with IEEE Std. 485-1983, the margins added for temperature ranges, load growth, and aging will provide adequate battery capacity to meet the battery duty cycle throughout its service life.*

4.6 An approved battery monitoring system may be provided at Remote Terminal applications. Alarms from the monitoring systems are defined in the Alarm Standards Technical Manual.

4.7 The replacement of VRLA individual cells or block replacement shall only be done under factory warranty conditions. When the cells are outside the warranty period, the entire string of VRLA's shall be replaced. When VRLA cells are defective, the condition of the entire string is highly suspect of being near failure as well. It is recommended that the entire string be replaced. When individual cells or blocks are replaced under warranty, the conductance or resistance of the new battery shall be matched with the rest of the string to optimize the life of the string. Placing a new battery in an existing string of batteries more than three yeas old is not recommended. Contact Environmental Management (EM) at 866-I WANT EM regarding battery removals.

5. Battery Installation & Storage

5.1 Batteries sent to a staging or storage facility prior to installation must be recharged within six months of the date of manufacture. Any cell left off charge greater than six months will have lost battery capacity and should not be accepted for installation. NiCad and LMP batteries are an exception to this rule. It is recommended that the NiCad and LMP cells are installed promptly, but the un-charged storage will not deteriorate the quality of the cell.

5.2 The SBC power equipment engineer shall provision battery cells of a common manufacturer and type within any given string. It is not acceptable to mix manufacturers or cell types within a single string for any battery technology. This practice is not permitted for new installations or single cell replacement at any time.

6. Battery Containment and Safety

6.1 The SBC power equipment engineer shall provide the initial necessary spill containment kit as required by the local, state and federal codes. Future additions, replenishments and replacement materials shall be the responsibility of the Local Field Operations (LFO).

6.2 Where not specifically defined by the local Authority Having Jurisdiction (AHF), SBC recognizes the use of the packaged electrolyte spill kit as the minimum for any Central Office application. A minimum of one drum per floor (assuming the floor is equipped with a DC Power Plant). The spill containment kit shall have enough approved neutralizing agent[2] included in it to contain the acid found from the largest battery located on that floor. If, the Central Office contains both

[2] Reference the Common Systems Power Approved Products List for details.

Flooded lead acid and NiCad, separate kits for each technology are required and should be appropriately labeled defining the usage. Kit components shall not be mixed between the two technologies due the potential of hazardous chemical reactions.

6.3 Acid absorbent kits shall be sized to accommodate the electrolyte clean up of the largest battery jar within the floor.

6.4 The SBC Power Technical Staff has recognized various acceptable methods for portable and permanently installed electrolyte spill containment that can meet the intent of various Fire coding bodies. The SBC Approved Products List (APL) should be consulted to determine the most current economical solution that can be deployed to the satisfaction of the AHJ. Some recent changes in Fire Safety codes have recognized flexible (boons) tubes containing absorbent as an acceptable method of containment. Where acceptable with the AHJ, this method can be considered a cost efficient, flexible method of complying to the code.

6.5 Where required to provide rigid individual battery string containment, the absorbent pillows shall not be included unless specifically required by the AHJ. Technically, the SBC approved spill containment system (including rigid walls and containment bladder) meet the intent of most fire codes without the need of additional protection. The absorbent found in the kit described in 6.2 further meet the intent of absorption/clean up requirements.

6.6 When containment is applied to the individual battery strings, adequate aisle spacing must be allowed to insure adequate space for battery installation and removal.

6.7 It is recommended by environmental management that “absorption methods” are used for electrolyte clean up vs. neutralization. Electrolytes can be either acid or alkaline based which require different and incompatible neutralizers. Also, absorption has proven to be the safest clean up method.

6.8 The type of spill kit required will be dependant upon battery type. Guidance on spill management is found in the “Battery, Power, and Engine Room” job aid on the SBC Corporate Safety website (worksafe.sbc.com). Once the spill is contained contact EM for proper disposal procedures (866-I WANT EM).

6.9 Eyewashes and other required personal safety products shall be provided. These products are not acid or alkaline specific, having a pH of 7 (they are the same as water). Refer to the “Battery, Power, and Engine Room” job aid found at the SBC Corporate Safety website (worksafe.sbc.com) for eyewash guidance..

6.9.1 **Uniform Fire Code (UFC) or International Fire Code (IFC) adopted Municipalities ONLY:** Authorized power equipment installation vendors working on the behalf of SBC- NP&E Power Equipment Engineers shall submit fire code design plans and obtain municipally required "Environmental Permits"[3] for flooded lead acid battery installations that are greater than 100/50[4] gallons of electrolyte. EM may be contacted for assistance in finding specific municipal contacts. The SBC power equipment engineer shall provide the required supporting data to the installation vendor for the permit application. Supporting data shall include, but not limited to:

- CAD drawings of the power area, including the new batteries and the proposed spill containment walls
- Written description of the existing batteries, and the proposed addition
- Full growth potential of the power plant
- Gallons of electrolyte being added

A copy of the completed environmental permit package shall also be forwarded to EM[5] by the authorized SBC Installation Vendor.

6.10 **California Only**: As dictated by the State of California Fire Code Enforcement Agencies, users of flooded battery products must comply with UFC 64 Section 6401, 6403, 6403.1, 6403.2 and 6403.3. Full rigid spill containment systems shall be included in all new and future Central Office flooded battery applications. This higher degree of spill containment applies to the State of California only. The methods described in 6.1-6.8 shall apply to applications outside of California.

6.10.1 In California, it is recommended that battery spill containment be approached as room containment in lieu of individual stand containment as the first choice. This shall also be a coordinated effort between the power equipment engineer, CRE-DC & EM utilizing the Building Work Request (BWR) to trigger the job.

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[3] Visit http://mechteam.sbc.com:8080/Power/Power_index.htm for the current M&P that includes various forms and letters to be used as communiqué with the Fire Code management agencies within the local municipalities.

[4] UFC 6401 – Scope Electrolyte capacities of 100 gallons in sprinkled buildings, 50 gallons for un-sprinked buildings.

[5] CRE-Environmental Management can be contacted at http://em.sbc.com/