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 Southwestern Bell, Pacific Bell, Nevada Bell, Ameritech and Southern New England Telephone (SNET).

2. Battery Types

2.1 Batteries used for telecommunications are either "flooded" lead acid type, Nickel Cadmium (NiCd), or valve regulated lead acid (VRLA) type.

2.2 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 or more years.

2.3 NiCd and VRLA batteries are primarily used in Remote Terminal (RT) applications where it is not practical to use flooded cells, either due to space requirements or maintenance requirements. NiCd batteries have an actual life of 15 to 20 years or more. This life expectancy stands true in the harshest of environments, where the VRLA batteries show an actual life of 2 to 4 years on average. VRLA batteries have an optimum life of 10 years in ideal environments.

2.4 NiCd and VRLA batteries use a recombinant technology. Hydrogen and oxygen gases produced within the cell are contained by the jar and a pressure-regulated valve. The VRLA recombination efficiency is far less than 100 per cent, caused by gas evolution through the jar material and poor valve performance. This leads to dry out and ultimately to failure of the cell. The NiCd recombination performance is near 100 per cent. Superior product design and materials used with the NiCd cell greatly reduce the dry out effect. Unlike the VRLA, the NiCd cells may be topped off with water to compensate for any dry out. The top off interval may be 8 years or more, however the manufacturer recommended interval is 5 years.

2.5 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. Ultimately the batteries destroy themselves and may harm adjacent equipment. The NiCd cell technology is not subject to this reaction based upon its design.

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;

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

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, busbars, power cable, battery cable and battery interconnects.

3.1.2 The SBC LEC Power Equipment Engineer shall engineer flooded lead acid batteries based upon a MVPC of 1.86 (24 cells per string). This satisfies the minimum voltage requirements of all central office switching and transport equipment in use today.

3.1.3 The SBC LEC Power Equipment Engineer shall engineer battery requirements for RT applications based upon the battery technology being used. With the use of NiCd batteries the MVPC shall be 1.10 (38 cells per string). With the use of VRLA batteries the MVPC shall be 1.75 (24 cells per string).

3.1.4 The SBC LEC 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.

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

3.2 Battery Reserve Time

3.2.1 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.

3.2.2 In all central office applications with a stationary Engine/Alternator set the SBC LEC Power Equipment Engineer shall provision a minimum of 4 hours battery reserve. This will be based upon Power Fail Loads (PFL) and the constant current drain tables provided by the battery manufacturer.

3.2.3 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

3.2.4 In RT applications the SBC LEC Power Equipment Engineer shall provision sites without stationary Engine/Alternator sets with 8 hours reserve. Any RT sites with stationary engine/alternator shall be provisioned with 4 hours reserve.

3.2.5 Battery reserve requirements for UN-interruptible power supply (UPS) units are outlined in BSP 790-100-660MP, AC Power.

4. 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, continual bubbling of battery acid within the cell and drastically deformed plates are signs that the cell has lost its capacity and is a candidate for replacement.
- Monitoring Environment: The ambient temperature of the battery room shall be monitored to ensure proper environmental conditions to prevent premature aging of cells.
- Resistance and/or Conductance Test: This method is a valid means of indicating the capacity of lead acid battery cells. Power Maintenance 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:

1. 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.
2. Inspection Methods – The three methods of inspection above 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 LEC Engineer and the appropriate de-ration applied based upon the physical condition of the cells.
3. 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 #2.

The SBC LEC Power Engineer shall apply the de-ration to the strings as appropriate to determine the estimated capacity of the battery plant. That figure shall then be applied to what is defined as the 'Power Fail Load' to determine if proper capacity is met. That process is outlined fully in BSP 790-100-652MP 'Planning & Structure, DC Power Plants, AC & DC Generation Sets'.

4.3 The ideal ambient temperature for either flooded lead acid, NiCd, 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.

4.4 Temperature compensation modules are required when using VRLA battery cells. They shall be alarmed for high temperature. NiCd 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.

4.6 An approved battery monitoring system may be provided with VRLA battery cells. 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 a string of batteries more than three yeas old is not recommended.

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. NiCd batteries are an exception to this rule. It is recommended that the NiCd cells are installed promptly but the un-charged storage will not deteriorate the quality of the cell.

5.2 The SBC LEC 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 install or single cell replacement at any time.

6. Battery Containment and Safety

6.1 The SBC LEC Power Equipment Engineer shall provide all necessary spill containment as required by the local, state and federal codes.

6.2 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.

6.3 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 hazardous Materials Management Handbook for specific instructions.